Effects of Parental Leave Policies on Female Career and Fertility Choices

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Abstract

This paper constructs and estimates a dynamic discrete choice structural model of female employment and fertility decisions that incorporates job protection and cash benefits of parental leave legislation. The structural model is used for ex ante evaluation of policies that change the duration of job protection and/or the arrangement for cash benefits. Counterfactual simulations indicate that introducing an initial one-year job protection policy increases maternal employment significantly, but extending the existing job protection period from one to three years has little effect. In addition, the employment effects of cash benefits seem modest. Overall, parental leave policies have little effect on fertility.

Keywords: parental leave, female labor supply, discrete choice model, structural estimation

JEL Codes: J13, J22, J24

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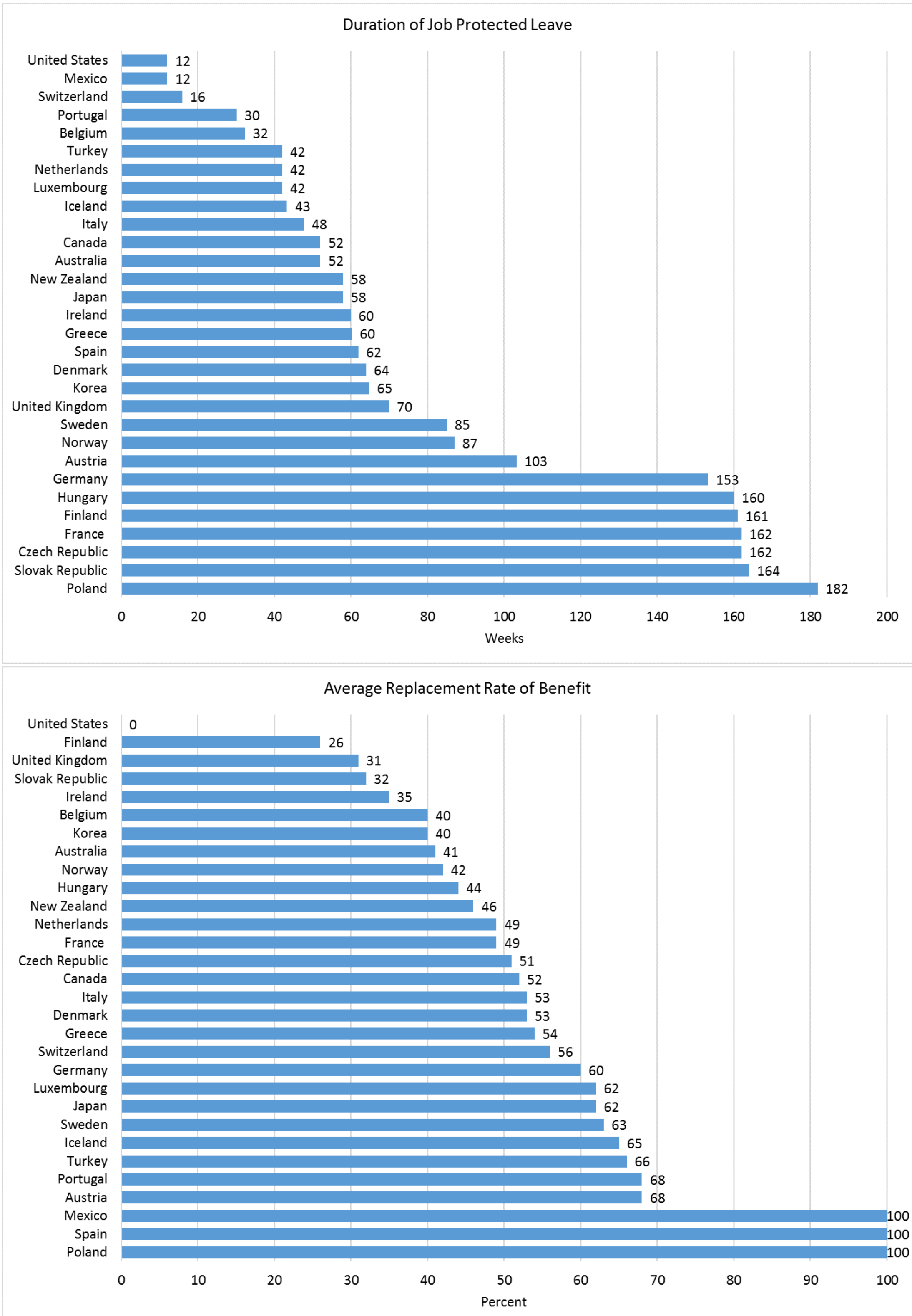
1 Introduction

Parental leave (PL) is mandated in most developed countries, but the generosity of PL legislation varies significantly across countries. Figure 1 presents international differences in the duration of job-protected leave and the replacement rate of cash benefits, that is, the percentage of employee compensation that is payable during PL. The US mandates only 12 weeks of unpaid job-protected leave, but many other countries, including Germany, France, and Finland, mandate job-protected leave for three years or more. The generosity of cash benefits also differs considerably across countries. The US is the only developed country where no mandated benefit is paid, while Mexico, Spain, and Poland pay 100% of pre-leave earnings to PL takers.

Policy makers in countries that mandate shorter job-protected leave and/or less generous cash benefits may be interested in expanding their PL policies to resolve the conflict between work and family life, which may lead to a higher fertility and labor force participation rate of mothers of young children. Predicting likely outcomes before a policy reform could help policy makers, but it is not necessarily straightforward. One can learn from the experiences of countries where the most generous PL policies are already mandated, but their experiences may not be fully generalizable to other countries because of differences in institutions, etc. Another way to assess the policy effects is to conduct a small-scale social experiment, but this may be costly and politically infeasible. Yet another approach to ex ante policy evaluation is to construct and estimate a structural model and conduct counterfactual simulations, which is the approach taken in this paper.

In the present paper, I construct and estimate a structural dynamic discrete choice model of women's employment and fertility that incorporates job protection and cash benefits of PL. In each period, a woman decides on her employment sector, PL take-up, and conception. When a mother of a young child works, she not only pays childcare costs, but also derives negative non-pecuniary utility of work because she values the time with her young child. Human capital increases with work experience through learning-by-doing, but it depreciates when she remains at home for PL. The model also incorporates the entry cost to employment for women who have stayed at home in the previous period. These features can be seen in some of the previous papers in the literature on the life-cycle model of female labor supply. Examples include, but are not limited to, Eckstein and Wolpin (1989), van der Klaauw (1996), Altug and Miller (1998), Francesconi (2002), Sheran (2007), Keane and Wolpin (2007, 2010), Adda, Dustmann, and Stevens (2011), and Gayle and Miller (2012).

The contribution of this paper is to model job protection and cash benefits of PL legislation. Job protection provided by PL allows mothers of newborns to stay at home without losing their jobs. In the model, PL takers can return to the pre-leave employment sectors without paying the entry costs, while those who quit their jobs without taking PL must pay to reenter employment.



Source: OECD Family Database

Figure 1: International Comparison of Parental Leave Legislation

Cash benefits of PL replace only a percentage of her pre-leave earnings while on PL and affect her decisions through the budget constraint.

The model is applied to panel data on Japanese women for the period 1993 to 2011. During that period, Japan experienced a series of PL reforms that expanded the coverage of the PL legislation and raised cash benefits. These policy variations allow me to identify the model without relying solely on functional form assumptions, which is a criticism to the structural estimation approach.

The estimation algorithm is based on the sequential algorithm proposed by Kasahara and Shimotsu (2011). Because the model allows for permanent unobserved heterogeneity using finite mixture, the Kasahara-Shimotsu algorithm is combined with the Expectation-Maximization (EM) algorithm developed by Arcidiacono and Jones (2003). To further accelerate computation, I also approximate the value function based on sieves using the method suggested by Arcidiacono, Bayer, Bugni, and James (2013). As far as I know, this is the first paper that combines these three methods. The proposed algorithm makes estimation tractable, despite the model's complexity.

Our model is relevant particularly for countries where the labor market is segmented, such as Southern European countries and Korea. In these countries and Japan, one sector consists of better-paid permanent jobs, while the other sector consists of lower-paid jobs that provide no security of continued employment. The model explicitly takes this aspect of the labor market into account and allows me to simulate a PL policy to see how PL policies influence the relative importance of each sector for women's career decisions.

The estimated model is used for counterfactual simulations to assess PL policies. In the first set of simulations, I evaluate the effects of job protection. This is particularly relevant in the context of real policy; the Prime Minister of Japan, Shinzo Abe, proposed extending the duration of job protection from one to three years to raise female labor force participation and the birth rate. [1] This proposal initiated a heated debate on whether Japan should reform its PL policies. The likely outcomes of the yet to be legislated reform are not well understood. Based on the structural estimation approach, the simulations in the present paper provide the best estimates for its effects.

The counterfactual simulations indicate that one-year job protection increases maternal employment after childbearing with effects that last for several years, compared with no mandated PL. Without job protection, many women quit their jobs at childbirth and slowly (or even never) come back to work. Job protection allows women to suspend working prior to childbirth without losing their jobs. Because PL takers maintain their employment contracts and do not pay entry costs, they return to work quickly after childbearing. However, extending the duration of job protection from one to three years has little effect. This is because the non-pecuniary utility of work is very negative when the child is newborn but becomes much smaller as the child grows to age one year or older. New mothers therefore take PL, but as their child grows beyond one year of age,

[1] See Abe (2013).

they return to work, even if they are eligible for PL for three years, because the utility loss falls below the utility gains from being employed. The simulations also indicate that policy effects on fertility seem modest for both one- and three-year job protection.

In the second set of simulations, I evaluate the effects of cash benefits. The simulation results indicate that raising the rate of cash benefits that accrue with job-protected PL has modest effects on maternal work and fertility. Overall, neither the duration of job protection nor cash benefits in the current PL legislation create a binding constraint for mothers of young children.

Most previous papers on PL policies and maternal labor supply identify the policy effects using a difference-in-differences (DID) estimator (Ruhm (1998), Baum (2003), and Baker and Milligan (2008a)) or regression discontinuity designs (Lalive and Zweimüller (2009), Schönberg and Ludsteck (2014), and Lalive, Schlosser, Steinhauer, and Zweimüller (2014)). The present paper differs from these previous papers by using a structural estimation approach to evaluate potential PL reforms.

Another difference from previous papers is that the structural approach sheds light on the mechanism by which the PL policies affect mothers' labor supply. Understanding the mechanism is important when interpreting the lessons from a particular country. The key finding of the present paper is that the non-pecuniary utility of work is a large negative for mothers of newborns, which is why one-year job protection helps women return to work after childbirth. This finding on the non-pecuniary utility of work is consistent with international evidence, including that from the US.[2] It should be noted, however, that differences in childcare and labor market institutions can affect the effectiveness of PL policies. On the one hand, job protection may be more effective in countries such as the US where childcare is not heavily subsidized, if other things remain equal. On the other hand, job protection may be less effective in the US because the labor market is more flexible and the entry costs to the employment sector are apparently smaller. The structural model helps one understand how PL policies affect maternal work and speculate about the potential policy effects in a given country.

The remainder of the paper is structured as follows. Section 2 describes the institutional background. Section 3 describes the data. Section 4 lays out the structural model. Section 5 outlines the estimation method. Section 6 presents the estimates of the structural parameters. The model's ability to fit to key aspects of the data is also demonstrated. Section 7 shows the effects of job protection and the cash benefits of PL through counterfactual simulations. Section 8 concludes the paper. Details regarding the data, estimation methods, and additional results are available in the appendices.

[2] See the discussion in Section 6.1 and papers cited there.

2 Institutional Background

The employment sector in Japan consists of two sub-sectors: the regular and non-regular employment sectors. Regular employment is typically under a permanent contract and a full-time job, while non-regular employment is typically under a limited-term contract and a part-time job. Regular jobs are usually superior to non-regular jobs in terms of hourly wages, non-wage benefits, employer-sponsored training, and eligibility for mandated PL (see Kambayashi and Kato (2013)). Women are predominant in the non-regular sector.

PL in Japan was first enforced in 1992. The legislation mandated job protection until the child reached age one, with no cash benefits. At the time, to be eligible for the mandated leave, individuals must have been employed in the regular employment sector and were expected to return to work after the completion of PL.[3]

Cash benefits were first introduced in 1995 with the replacement rate at 25%, and subsequently raised to 40% in 2001. Like many other countries, including Austria, Canada, and Germany, cash benefits are not financed directly by employers, but rather by employment insurance. An important difference from some other countries is that cash benefits are tied to the job from which PL is taken. In other words, PL takers are expected to return to the pre-leave job in order to receive cash benefits, although PL takers can reduce their hours of work if they wish. This requirement is imposed to encourage women to stay in the labor market after childbearing. PL takers must apply through employers to receive cash benefits so that employers provide proof of expectation of returning to work. Although there is no legal penalty for not returning, about 90% of PL takers are employed one year after childbearing (see Table 5).

The next major PL reform took place in 2005, when non-regular workers became eligible for mandated PL for the first time. Since then, PL legislation has treated regular and non-regular workers equally. In 2007, the replacement rate was raised to 50%. Table 1 summarizes the changes in PL policies.

There are two other relevant issues regarding PL. First, if a PL taker gives birth during her leave, she can renew the PL and receive cash benefits. Second, not only mothers, but also fathers, are eligible to take PL; however, very few fathers do so. In 2010, the PL take-up rate among fathers was 1.38%, and more than half of male PL takers were on leave for only one week.

[3] Strictly speaking, the legal eligibility for PL is determined by whether the employment contract is limited or indefinite term. The data do not ask the term of the employment contract, but do ask whether the job is regular or non-regular employment. Because indefinite term employment is usually regular employment and vice versa, I determine eligibility by employment type.

Table 1: Changes in Parental Leave Policies

Years	Eligibility		Job Protection	Replacement Rate	Legislated On	Enforced On
	Regular	Non-Regular				
1992-1994	✓		1 Year	0%	1991/05/15	1992/04/01
1995-2000	✓		1 Year	25%	1994/06/29	1995/04/01
2001-2004	✓		1 Year	40%	2000/05/12	2001/01/01
2005-2006	✓	✓	1 Year	40%	2004/12/08	2005/04/01
2007-2012	✓	✓	1 Year	50%	2007/04/23	2007/04/01

3 Data

3.1 Overview of the Data Structure

The analysis is based on data from the Japanese Panel Survey of Consumers (JPSC) conducted by The Institute for Research on Household Economics. The JPSC started in 1993 with a representative sample of 1,500 women aged 24–34 years and asks respondents about marriage, fertility, and their and their spouse's work every survey year. The JPSC added 500 women aged 24–27 years in 1997, 836 women aged 24–29 years in 2003, and 636 women aged 24–28 years in 2008. As of 2008, the JPSC had sampled 2,284 women. Observations from the JPSC from 1993 to 2011 are used for this study.

From this representative sample of young women, I drew a sample of married women who completed schooling and were not self-employed. After omitting observations with missing values except for self-earnings, I took the longest spell of consecutive observations for each individual. In total, the sample comprises 1,826 women and about eight observations per person (14,907 person-year observations in total).

The empirical definitions of eligibility for PL and PL take-up are detailed in Appendix A.1 along with other variables, including decision variables for employment sectors and fertility, sector-specific experiences, etc.

Table 2 presents summary statistics for the pooled sample. The age of sampled individuals ranges from 24–52 years, which means the sample covers more than 89% of childbirths, according to Vital Statistics 2011.[4] Average years of education is 13.211, while average years spent at home since completing education and experiences in the regular and non-regular sectors are 5.580, 6.573, and 3.271, respectively. Average number of children is 1.720. The average earning of husbands is 5.103 million JPY, which is approximately equal to 51,030 USD. The average earning of the wives is 0.859 million JPY.

[4] In total, 89% of children are born to mothers aged 25 years or older.

Table 2: Summary Statistics

	Mean	Std. Dev.	Min.	Max.
Individual Characteristics				
Age	35.239	5.976	24	52.000
Education	13.211	1.634	9	18.000
Years in Home	5.580	4.791	0	26.000
Years in Reg Work	6.573	5.091	0	34.000
Years in Non-Reg Work	3.271	4.135	0	26.000
No. of Children	1.720	0.966	0	4.000
Husband's Earnings	5.103	2.027	0	45.000
Earnings	0.859	1.423	0	8.964
Employment and Fertility Choices				
Home	0.503	0.500	0	1.000
Reg Work	0.188	0.391	0	1.000
Non-Reg Work	0.292	0.455	0	1.000
PL	0.017	0.130	0	1.000
Pregnancy	0.081	0.274	0	1.000

No. of Obs. (Person-Year)	14907
No. of Persons	1826

Source: JPSC

Note: The sample includes married women who completed schooling and are not self-employed. Earnings are in million yen (≈10,000 USD) in 2010 constant price. The earnings of those who do not work are counted as zero.

3.2 Descriptive Analysis

3.2.1 Life-Cycle Profiles

Table 3 shows average labor market and fertility outcomes by age. The percentage staying at home at age 30 years is high, at 59%, but this gradually decreases with age. At age 45 years, 31% of married women stay at home. These statistics are comparable with those from the Labor Force Survey 2010.[5] Similar percentages of mothers work in the regular and non-regular sectors at age 30 years (17.8% and 19.4%, respectively). While the percentage of regular workers slowly increases after age 35, that of non-regular workers grows much more rapidly. At age 45, the percentage of regular workers is 23.5%, but that of non-regular workers is higher, at 45.4%. These statistics suggest that women gradually return to the labor market after childbearing, but largely to non-regular employment.

The percentage of PL takers is small, at 3.7% at age 30 years, and gradually decreases with age. The percentage of pregnant women is 1.66% at age 30 years, and this decreases to 5.3% at age 35 years. No women aged 45 years in the sample were pregnant. Self and husbands' earnings increase over time. A woman's earnings are 0.673 million JPY at age 30 years, but this increases to 1.302 million JPY at age 45 years as more and more individuals participate in the labor force. Husbands' earnings grow from 4.482 million JPY at age 30 years to 6.022 million JPY at age 45 years. The number of children of married women at age 30 years is 1.407. This grows over time, and the completed fertility rate (at age 45 years) for married women is 2.089.

3.2.2 Employment Transitions

Table 4 shows the transition matrix for employment choices. The rows indicate employment choices in year $t-1$, the columns indicate employment choices in year t. Employment choices are serially correlated except for PL. For those who stayed at home in $t-1$, 88.6% stay at home in t again. Similarly, 82.6% of those who worked in the regular sector and 84.7% of those who worked in the non-regular sector in year $t-1$ work in the same sector in year t again. This serial correlation can be driven by heterogeneity, state dependence, or both.

Sector-specific human capital is a possible explanation for state dependence. Individuals lose their sector-specific human capital when they leave the current employment sector, which discourages them from switching sectors. Another possible explanation is an entry barrier to employment sectors. If finding new employment requires a significant search effort, the chance of entering a new employment sector is low.

[5] According to the Labor Force Survey in 2010, 56%, 45%, and 33% of married women aged 30–34 years, 35–39 years, and 40–44 years, respectively, are out of the labor force.

Table 3: Labor Market and Fertility Outcomes by Age

	Age			
	30	35	40	45
	N=916	N=907	N=592	N=293
Home	0.591	0.535	0.419	0.311
	(0.016)	(0.017)	(0.02)	(0.027)
Reg Work	0.178	0.172	0.208	0.235
	(0.012)	(0.013)	(0.017)	(0.025)
Non-Reg Work	0.194	0.276	0.367	0.454
	(0.013)	(0.015)	(0.02)	(0.03)
PL	0.037	0.018	0.007	0
	(0.006)	(0.004)	(0.003)	(—-)
Pregnancy	0.166	0.053	0.012	0
	(0.012)	(0.008)	(0.004)	(—-)
Earnings	0.673	0.755	1.067	1.302
	(0.041)	(0.044)	(0.067)	(0.102)
No. of Children	1.407	1.867	2.007	2.089
	(0.03)	(0.031)	(0.036)	(0.051)
Husband's Earnings	4.482	5.172	5.723	6.022
	(0.062)	(0.06)	(0.093)	(0.136)

Source: JPSC

Note: The sample includes married women who completed schooling and are not self-employed. Earnings are in million yen (≈10,000 USD) in 2010 constant price. Standard errors are in parenthesis. They are clustered at individual level and calculated by bootstrapping with 1,000 replications.

For those who stay at home, entering the regular sector seems harder than entering the non-regular sector. Among those who stay at home during a year, 10.9% begin working in the non-regular employment sector, but only 1.0% find a job in the regular employment sector.

The vast majority of PL takers in $t-1$ return to work in t. Only 10.3% of them quit their job and stay at home in year t. About 65.3% of them return to work in the regular sector, while 12.2% return to work in the non-regular sector. Finally, 12.2% continue on PL for another year.

Table 4: Transition Matrix for Employment Choice

	Choice in t			
	Home	Reg	Non-Reg	PL
Choice in $t-1$				
Home	0.886	0.01	0.104	0
	(0.005)	(0.001)	(0.004)	(—-)
Reg	0.066	0.826	0.038	0.071
	(0.005)	(0.01)	(0.004)	(0.006)
Non-Reg	0.109	0.037	0.847	0.007
	(0.006)	(0.003)	(0.008)	(0.001)
PL	0.103	0.653	0.122	0.122
	(0.021)	(0.035)	(0.025)	(0.024)

Source: JPSC
Note: The sample includes married women who completed schooling and are not self-employed. Standard errors are in parenthesis. They are clustered at individual level and calculated by bootstrapping with 1,000 replications.

3.2.3 Parental Leave Take-Up Rate

Table 5 shows the PL take-up summary statistics. Among women who give birth, only about 30% hold a job eligible for PL at childbirth. Although 58% of women eligible for mandated PL take leave, about 30% of women eligible for mandated PL quit their job without taking PL. The remaining 12% of eligible women continue to work without taking PL. Although there is no penalty for not returning, about 90% of leave takers return to employment a year after childbearing.

Note that there is no formal penalty even if a woman takes PL and collects cash benefits but does not eventually return to work. It seems that all eligible women should take PL and collect cash benefits regardless of whether they intend to return, but about 30% actually end up quitting their jobs without collecting cash benefits. A possible explanation for this low PL take-up rate is the transaction cost or non-pecuniary disutility of taking PL. This issue is extensively discussed when I model PL take-up behavior in Section 4.2.2.

Table 5: Summary Statistics for PL Take-Up

	Mean	Std. Error
Among Those Who Give Birth		
(1) Eligible for PL	0.293	0.016
Among Those Who Are Eligible for PL		
(2) Quit and Stay Home	0.296	0.027
(3) Take Up PL	0.584	0.030
(4) Work	0.119	0.020
Among Those Who Took PL Last Year		
(5) Employed	0.898	0.021

Source: JPSC
Note: The sample includes married women who completed schooling and are not self-employed. Standard errors clustered at individual level and calculated by bootstrapping with 1,000 replications.

4 Model

4.1 Setup

The labor supply and fertility decisions of married women are modeled using a dynamic discrete choice framework. In each calendar year t, a forward-looking woman maximizes her present value of lifetime utility by deciding on labor supply and fertility. She retires from the labor market and receives the terminal value of zero at age 65 years.[6] Individuals differ in their unobserved characteristics, including permanent skills in regular and non-regular sectors, non-pecuniary utility from work and children, and their husbands' permanent skills.

4.1.1 Choices

There are four employment choices: (1) staying at home, (2) working in the regular employment sector, (3) working in the non-regular employment sector, and (4) taking PL. Let $d_{h,it} = 1$ if individual i in year t stays at home and $d_{h,it} = 0$ otherwise. The decision variables for working in the regular sector $d_{r,it}$, working in the non-regular sector $d_{n,it}$, and taking PL $d_{l,it}$ are similarly defined. The labor supply choices are exhaustive and mutually exclusive.

PL is in the choice set only when an individual has been employed in the previous year in either the regular or non-regular sector and has a child aged between zero and two years. This restriction is less strict than the legislation requiring an individual to have a child under the age of one year and to have been employed in the eligible employment sector in the previous year. This is because

[6] All the results are qualitatively unchanged when the retirement age is set at 70 years.

many women in the data who have been employed in the non-covered sector and/or have a child aged one year or older report their PL take-up. As I detail in Section 4.2.2, the non-pecuniary costs of PL depend on formal eligibility.

Individuals also decide on whether they will conceive. If a woman conceives in year t, she will give birth in the following year $t+1$. Let $d_{f,it} = 1$ if individual i conceives in year t and $d_{f,it} = 0$ otherwise. A woman does not make a fertility decision after age 45 years.

Because there are four labor supply choices and two fertility choices, there are eight choices in total. Therefore, a vector of decision variables is $d_{it} = (d_{h,it}, d_{r,it}, d_{n,it}, d_{l,it}, d_{f,it})$.

4.1.2 State Variables

The current period payoff for individual i from her choice in year t is affected by a vector of her state variables S_{it} that include sector-specific experiences ($x_{h,it}$, $x_{r,it}$, and $x_{n,it}$), her own age a_{it}, age of the youngest child $a_{k,it}$, number of children n_{it}, earnings of the male spouse $y_{m,it}$, lagged choices d_{it-1}, lagged employment status e_{it-1}, and calendar year t.

Note that PL takers are not currently working, but maintain their employment contract. Let $e_{r,it} = 1$ if individual i is employed in the regular sector and $e_{r,it} = 0$ otherwise. The indicator for employment in the non-regular sector $e_{n,it}$ is similarly defined. One cannot be employed in more than one sector, implying that $e_{r,it} + e_{n,it} \leq 1$. Define a vector of variables for employment status $e_{it} = (e_{r,it}, e_{n,it})$.

The transition of state variables is deterministic except for the earnings of the male spouse (see Section 4.3).[7] Individuals form expectations for the state variables in the next period according to the model, but policy changes are assumed exogenous and unexpected. This assumption is consistent with the fact that individuals are unlikely to be able to time their childbearing to benefit from more generous PL policies, because the new policies were enforced at most nine months after legislation.[8] Technically, this is implemented by assuming that individuals expect that the calendar year as a state variable does not change from this year to next, which also implies that individuals expect the unemployment rate to remain at the current level.

[7] The transition of employment status may need an explanation. I have $e_{r,it} = 1$ if $d_{r,it} = 1$ or ($d_{l,it} = 1$, $e_{r,it-1} = 1$) and $e_{r,it} = 0$ otherwise, because one can maintain her employment contract while on PL. The variable $e_{n,it}$ is similarly defined.

[8] See Table 1 for timing of legislation and enforcement. The PL was first legislated on May 15, 1991 and enforced on April 1, 1992. Because there are more than 10 months between legislation and enforcement, timing birth to take advantage of the reforms was possible. However, the survey used in the present paper began after this reform, so this does not affect the analysis.

4.2 Preference

4.2.1 Consumption

The utility from consumption u is given by

$$
\begin{aligned}
u(C_{it}, n_{it}, d_{it}) &= \alpha(d_{it}, n_{it}) \cdot C_{it} \\
&= [\alpha_1 + \alpha_2 d_{r,it} + \alpha_3 d_{n,it} + \alpha_4 \sqrt{n_{it}}] \cdot C_{it}. \qquad (1)
\end{aligned}
$$

This specification implies that the marginal utility of consumption varies with non-market time and the number of children. This non-separability of consumption and non-market time was introduced by Eckstein and Wolpin (1989) and adopted by subsequent papers in the literature. If $\alpha_2 < 0$ and $\alpha_3 < 0$, then women having higher-income husbands are less likely to work, which is widely observed across countries.[9]

The household consumes all the income earned in a given year. The budget constraint is

$$
C_{it} = y_{m,it} + d_{r,it} y_{r,it} + d_{n,it} y_{n,it} + d_{l,it} b_{it} - (d_{r,it} + d_{n,it}) CC(a_{k,it}), \qquad (2)
$$

where $y_{m,it}$ is earnings of husband, $y_{r,it}$ is earnings in the regular employment sector, $y_{n,it}$ is earnings that individual i would make in year t if she works in the non-regular employment sector, b_{it} is the cash benefit for PL, and $CC(\cdot)$ is the childcare cost that depends on the age of the youngest child.[10] Details of earnings and childcare costs are given in Section 4.3.

To achieve computational tractability, saving decisions are assumed away. This assumption may be restrictive, but is common in the literature of female life-cycle labor supply (for example, see Eckstein and Wolpin (1989), van der Klaauw (1996), Francesconi (2002), and Keane and Wolpin (2007, 2010).). This is because female life-cycle labor supply models need to incorporate fertility decisions and the effects of children, which is substantially more complicated than male labor supply models. The potential biases from ignoring saving decisions are not well understood, but I examine the extent to which omitting saving decisions is likely to bias the predicted employment and fertility choice probabilities in a reduced form fashion in Section 6.3.

[9] To see this, compare utility from consumption when working in the regular sector and when staying at home. Ignore children and the childcare cost for simplicity. Utility from consumption when working in the regular sector is $(\alpha_1 + \alpha_2)(y_{m,it} + y_{r,it})$ and utility from consumption when staying at home is $\alpha_1 y_{m,it}$. The utility difference between the two is $(\alpha_1 + \alpha_2) y_{r,it} + \alpha_2 y_{m,it}$. When $\alpha_2 < 0$, the utility gain from working relative to staying at home decreases with husband's income $y_{m,it}$, and hence, women having higher-income husbands are less likely to work.

[10] For computational tractability, I am unable to include the age of older children in the state variables, which may result in underestimating the true cost of daycare. This potentially biases the effects of the number of children on the non-pecuniary utility from the labor supply choice, which will be described in the next subsection.

4.2.2 Non-Pecuniary Utility from Labor Supply Choices

Working in the Regular or Non-Regular Sector Individuals derive non-pecuniary utility from work that depends on the lagged dummy for staying at home $d_{h,it-1}$, the lagged employment sectors e_{it-1}, the number of children n_{it}, the age of the youngest child $a_{k,it}$, and the unemployment rate UR_t. The non-pecuniary utility from employment choices is normalized by setting the utility of staying at home zero and parametrized as follows:

$$v_{j,it} = \gamma_{ij,1} + \gamma_{j,2} d_{h,it-1} + \gamma_{j,3} e_{k\neq j,it-1} + \gamma_{j,4} d_{l,it-1} e_{j,it-1} + \gamma_{j,5}\sqrt{n_{it}} + \gamma_{j,6}(a_{k,it}) + \gamma_{j,7} UR_t, \quad (3)$$

where $j = n, r$.

The intercept $\gamma_{ij,1}$ varies across individuals to allow for heterogeneous preferences for work. The second, third, and fourth terms are the entry costs to the employment sector j, when the woman stayed at home, when she was employed in the other sector k, and when she took PL in the same sector in the last year, respectively. I expect that the estimated entry cost for PL takers $\gamma_{j,4}$ is close to zero, because PL takers maintain their employment contracts while on PL. Hence, job protection helps women return to work after childbearing, and this is particularly useful in countries where the labor market is rigid, such as Japan and Southern European countries.[11] These entry costs are consistent with the serially correlated employment transition in Table 4 and included in many previous life-cycle models of labor supply (e.g., Keane and Wolpin (1997)).

The fifth and sixth terms are the effects of the number of children and the age of the youngest child on non-pecuniary utility from work. Children may affect non-pecuniary utility from work, because mothers care about the health and development of their children and believe that their market work may affect these outcomes. Social norms may also lower mothers' non-pecuniary utility from work by making them feel guilty. In addition, mothers may need rest for their own health immediately after childbirth.

The sixth term (or function $\gamma_{j,6}(\cdot)$) takes six different values depending on which of the following six age groups the age of the youngest child falls in: 0, 1, 2, 3-5, 6-11, and 12 years and older. This functional form is more flexible than previous structural models[12] and motivated by the literature on child development. Waldfogel, Han, and Brooks-Gunn (2002), Baum II (2003), James-Burdumy (2005), and Bernal (2008) find that maternal work affects child development differently depending on the age group the child is in, and has a detrimental effect when the child is aged less than one year. In addition, World Health Organization and UNICEF (2003) recommend exclusive breastfeeding up to six months of age, with continued breastfeeding along with

[11] See Del Boca, Aaberge, Colombino, Ermisch, Francesconi, and Pasqua (2003).

[12] As far as I know, Keane and Wolpin (2010) and Gayle and Miller (2012) allow for a newborn child to affect mothers' utility from work differently from older children. Other papers make no distinction between newborns and older children.

foods up to age two years. As shown by Baker and Milligan (2008b), maternal work can prevent breastfeeding, which may affect mothers' disutility from work while the child is young.

Finally, the national level unemployment rate UR_t is included to capture possible changes in working conditions and fringe benefits over business cycles that may affect the non-pecuniary utility of work.

Taking Parental Leave In contrast to previous papers that assume all child-bearers receive cash benefits automatically, the model incorporates PL as a choice. The key assumption here is that there is a transaction cost for taking up PL, which I infer from the fact that not all eligible women take PL (see Table 5). Remember that there is no formal penalty for not returning after taking up PL and cash benefits, which seems to imply that all mothers legally eligible for PL should take it and collect cash benefits regardless of whether they intend to return. Indeed, in the data, about 30% of eligible women quit their jobs without collecting cash benefits. To rationalize this observed PL take-up behavior, I assume the existence of non-pecuniary cost of taking up PL.

Incomplete take-up is common to many social benefits. Currie (2006) surveys the literature on the take-up of social benefits and reports that low take-up is a problem with not only means-tested benefits, but also non-means-tested benefits. In the literature, the rationale for low take-up includes stigma, transaction cost, and the cost of acquiring information, although these are not entirely separate explanations.

For PL in Japan, stigma is unlikely to account for the low take-up because it is not means-tested. Instead, transaction cost and cost of information acquisition may prevent women from taking PL. Workers requesting leave need to speak to their supervisor to discuss working arrangements while they are on leave and when they return. Employers may be reluctant to provide information and make arrangements regarding PL take-up because a period of PL creates a cost: that of hiring a temporary replacement. Coworkers may also not be supportive because someone's PL may imply more work for them, particularly in a smaller establishment.

The non-pecuniary utility for PL take-up is parametrized as

$$v_{l,it} = v_{il,1} + v_{l,2} e_{r,it-1} + v_{l,3} ELG_{it} + v_{l,4} d_{l,it-1}(1 - ELG_{it}), \tag{4}$$

where ELG_{it} is a dummy variable that takes one if individual i is legally entitled to PL in year t and zero otherwise. An individual is legally entitled to PL if (1) the age of the youngest child is zero and (2) she has been employed in the eligible sector in the previous year. Only employees in the regular employment sector were eligible throughout the period of analysis; employees in the non-regular sector were not eligible until 2005.

The first term is the baseline transaction cost for PL take-up. This varies between individuals.

The second term is difference between transaction cost of regular and non-regular workers, because employers are more willing to award PL to regular workers. The third term is the effect of legal eligibility on the transaction cost. Legal entitlement is expected to decrease the take-up cost of PL because it makes their PL take-up easier to justify to managers and coworkers. The fourth term is the additional PL take-up cost when PL is taken by an ineligible individual. This is relevant mostly for those who extend their PL beyond their child's first birthday.

4.2.3 Non-Pecuniary Utility from Children

At the time of conception, a married woman derives utility from children as a lump sum, which is specified as

$$v_{f,it} \quad = \quad \gamma_{if,1} + \gamma_{f,2} d_{r,it} + \gamma_{f,3} d_{n,it} + \gamma_{f,4}(a_{it}) + \gamma_{f,5}(a_{k,it}, n_{it}). \tag{5}$$

The first term is the intercept and varies between individuals to account for heterogeneous preferences for children. The second and third terms are the effects of working in the regular and non-regular sectors in the current year, respectively. The fourth term is a quadratic function of own age. The fifth term is a flexible function of the age of the youngest child and the number of children. The age of the youngest child is included to account for birth-spacing.

4.3 Income and Cost of Childcare

Self-Earnings The earnings functions are sector-specific and given by

$$y_{j,it} \quad = \quad \omega_{ji,1} + \omega_{j,2}(x_{j,it}, x_{k \neq j,it}) + \omega_{j,3}(x_{h,it}) + \omega_{j,4}(d_{it-1}) + \omega_{j,5} UR_t + \eta_{j,it}. \tag{6}$$

where $j = n, r$. The intercept varies across individuals to account for heterogeneous sector-specific skills. Note that education is not explicitly included in the earnings function, but it may be correlated with the intercept, which varies between individuals, as explained in Section 4.5. The second term is a quadratic function of experiences in the current and other sectors. The third term is a quadratic function of years spent at home and accounts for permanent human capital depreciation. The fourth term is the transitory change in human capital and a function of lagged labor supply choices. This is included to account for the fact that the individual needs some start-up training to adjust herself to a new work environment. The fifth term is the effect of the national unemployment rate that proxies overall labor market conditions. The last term $\eta_{j,it}$ is a measurement error that follows a normal distribution with zero mean and variance σ_y^2.

Cash Benefits To be eligible for cash benefits, a mother must apply for job-protected PL that maintains the employment contract. Tying cash benefits to job-protected PL is the key difference from other countries such as Canada and Germany. In these countries, mothers must have worked before childbearing, but they do not need to take job-protected PL to maintain their employment contract.

Cash benefits replace a fraction R_t of pre-leave earnings up to 5.112 million JPY ($\approx$ 51,120 USD) per year, net of the bonus. In the JPSC, gross labor earnings including bonuses are reported, so they have to be scaled downward. According to the Basic Survey on Wage Structure 2008, regular workers' bonuses per year are worth about the same as three months of earnings,[13] while that of non-regular workers was worth about the same as one month of earnings. Given these statistics, earnings net of the bonus for a regular worker is 12⁄15 of gross earnings, while that for a non-regular worker is 12⁄13 of gross earnings, as reported by the JPSC. Formally, the cash benefits of PL are given by

$$b_{it} \quad = \quad R_t \min\left[5.112,\ d_{r,it-1}\frac{12}{15}\hat{y}_{r,it} + d_{n,it-1}\frac{12}{13}\hat{y}_{n,it}\right], \tag{7}$$

where R_t is the replacement rate and $\hat{y}_{j,it}$ $(j = i,n)$ is the predicted earnings in sector j, which is based on the current state variables and earnings equation (6). Because the exact pre-leave salary is not included in the state variable to reduce computational burden, it is approximated by the predicted earnings in year t. Changes in the replacement rate of the cash benefit R_t over time are summarized in Table 1.

Earnings of Husband The earnings of husbands are modeled by a flexible function of state variables with little emphasis on a structural interpretation. It is specified as

$$y_{m,it} \quad = \quad \omega_{mi,1} + \omega_{m,2}y_{m,it-1} + \omega_{m,3}(a_{it}) + \omega_{m,4}(a_{k,it}, n_{it}) + \omega_{m,5}(d_{it}) + \omega_{m,6}UR_t + \eta_{m,it}. \tag{8}$$

The first term $\omega_{mi,1}$ varies across individuals to allow for the difference in the husband's unobserved permanent skills. The lagged earnings of the husband are included to allow for serial correlation. The third term is a quadratic function of the age of the wife. The fourth term is a function of the age of the youngest child and the number of children. The fifth term is the current labor supply and fertility choices. The sixth term is the effect of the unemployment rate in year t to capture the

[13] For regular workers, the average monthly earnings without a bonus were 243,900 JPY, and the average bonus in 2008 was 724,000 JPY. For non-regular workers, the average monthly earnings without a bonus were 170,500 JPY and the average bonus in 2008 was 140,800 JPY.

overall labor market conditions. The last term $\eta_{m,it}$ is an i.i.d. income shock that follows a normal distribution with a zero mean and variance σ_m^2.

Cost for Childcare The cost for childcare $CC(a_{k,it})$ is a function of the age of the youngest child. The Survey of Regional Child Welfare Services 2003 reports the average monthly fees for non-accredited childcare by child's age. The actual childcare costs vary by individuals for a variety of reasons, but using the reported childcare costs raises the concern of endogeneity biases. My approach is to use the average of the list prices. The childcare cost is given by

$$\begin{aligned} CC(a_{k,it}) &= [I(a_{k,it}=0)\cdot 43739 + I(a_{k,it}=1)\cdot 40660 + \\ &\quad I(a_{k,it}=2)\cdot 38179 + I(3 \le a_{k,it} \le 5)\cdot 34181] \times 12/1000000, \end{aligned} \tag{9}$$

where $I(\cdot)$ is an indicator function that takes the value of one if the condition in the parenthesis is satisfied and takes zero otherwise. The monthly childcare cost for children under one year of age is only 43,739 JPY ($\approx$ 437 USD), because it is heavily subsidized. The fee tends to be lower for older children, but the fee difference across ages is not large.

4.4 Utility Maximization

The objective of a married woman is to maximize the present discount value of her lifetime utility. Her value function V is recursively defined as

$$\begin{aligned} V(S_{it}, \varepsilon_{it}) &= \max_{d_{it}} u(C_{it}, n_{it}, d_{it}) + d_{r,it}v_{r,it} + d_{n,it}v_{n,it} + d_{l,it}v_{l,it} + d_{f,it}v_{f,it} + \varepsilon_{it}(d_{it}) + \\ &\quad \beta E[V(S_{it+1}, \varepsilon_{it+1})|S_{it}, d_{it}] \end{aligned} \tag{10}$$

where β is a discount factor. Her current payoff is also affected by a preference shock $\varepsilon_{it}(d_{it})$ specific to a choice d_{it}, which are allowed to be correlated among them as described below, but are independent of all other variables.

The choice-specific shocks follow a generalized extreme value distribution so that they can be correlated with each other. The choice probability is modeled by the generalized nested logit model that allows for overlapping nests, following Wen and Koppelman (2001). Eight choices are grouped by whether to work and whether to conceive. There are four nests of alternatives labeled as $B_1, \cdots, B_4$. Nest B_1 includes alternatives for non-conception ($d_{f,it} = 0$) regardless of labor supply choices, nest B_2 includes alternatives for conception ($d_{f,it} = 1$) regardless of labor supply choices, nest B_3 includes alternatives for work ($d_{r,it} = 1$ or $d_{n,it} = 1$) regardless of fertility choices, and nest B_4 includes alternatives for non-work ($d_{h,it} = 1$ or $d_{l,it} = 1$) regardless of fertility choices. A detailed explanation of the generalized nested logit model is given in Appendix B.1.

4.5 Unobserved Heterogeneity

Permanent unobserved heterogeneity is modeled as a finite mixture. Individuals are one of the K types, but the type of an individual is not observed. Following Wooldridge (2005), to address the initial condition problem, I allow for the probability of being type k to depend on the observed characteristics and choices in year $t = \tau(i)$ that is the first year when individual i is observed in the data. Define $z_{i\tau(i)}$ as a vector of observed characteristics and choice in year $\tau(i)$: $z_{i\tau(i)} = (d_{i\tau(i)}, S_{i\tau(i)}, edu_i)$ where edu_i is years of education. Note that education is time-invariant in the model and included here to allow for the correlation between education and unobserved skills and preference.[14] The state variables in the first year seen in the data or year $\tau(i)$ include age, years in home, regular, and non-regular sectors, the interactions of age and years in home, regular, and non-regular sectors, husband's earnings, number of children, and age of youngest child.

The probability that individual i is type k is given by

$$p_k(z_{i\tau(i)}) = \frac{\exp(\pi_k' z_{i\tau(i)})}{\sum_{\kappa=1}^{K} \exp(\pi_\kappa' z_{i\tau(i)})}. \tag{11}$$

For normalization, the parameters for the first type is set zero so that $\pi_{\kappa=1} = 0$.

4.6 Comparison with Previous Structural Models

A few previous structural estimation papers model and/or simulate PL policies. Gayle and Miller (2012) simulate the effects of cash benefits on fertility and labor supply, but the role of job protection or PL take-up is not considered. Adda, Dustmann, and Stevens (2011) include job protection and cash benefits in their model, but they do not model PL take-up behavior and assume that all women giving birth take PL and receive job protection and cash benefits. In addition, Adda, Dustmann, and Stevens (2011) do not study the effects of PL policies specifically. Modeling PL take-up is fruitful if PL is not universal or if the take-up rate is less than 100%. The Family and Medical Leave Act (FMLA) in the US provides job protection, but it applies to public sector employment and to private companies with 50 or more employees. Although PL is universal, the take-up rate[15] is about 50% in Germany, according to Schönberg and Ludsteck (2014). Given these facts, not modeling PL take-up and instead assuming that all women take PL may result in biased estimates for the effects of PL policies.

[14] Education could be included in the intercepts of the utility and earnings functions as an alternative specification, but doing so expands the state space. Remember that computational cost exponentially rises with the size of the state space. My preferred choice is to introduce time-invariant unobserved skills and preferences and allow for correlation with education, which saves computational burden.

[15] Measured by the number of PL take-ups divided by the number of births.

Lalive, Schlosser, Steinhauer, and Zweimüller (2014) appears to be the structural estimation paper closest to the present paper. Their model, however, is based on the continuous-time job search model of Frijters and van der Klaauw (2006) instead of the discrete choice framework adopted by this paper. This paper differs from Lalive, Schlosser, Steinhauer, and Zweimüller (2014) in three important ways. First, I model PL take-up, the importance of which is explained above. Second, I allow for fertility choice. If a PL reform affects fertility decisions as in Lalive and Zweimüller (2009) and fertility affects labor supply decisions, then the estimated policy effects on maternal labor market outcomes may be biased if fertility is assumed exogenous. Third, I consider not only labor force participation decisions, but also occupational choices (regular vs. non-regular jobs). The simulation results below indicate that the policy effects differ between the two jobs.

5 Estimation Strategy

5.1 Estimation Algorithm

The model is estimated by the maximum likelihood method. I describe the details of the likelihood function in Section B.1 for interested readers.

The maximum is found by combining the three algorithms that accelerate computation. The main algorithm is developed by Kasahara and Shimotsu (2011), and their algorithm sequentially updates the parameter and the value function estimates. For each likelihood evaluation, the value function is iterated for a small number of times rather than until convergence, which significantly reduces the computational time. To accelerate the computation for the value function iteration in evaluating the likelihood, the value function is approximated by sieves using the method proposed by Arcidiacono, Bayer, Bugni, and James (2013). When the state space is large, this sieve approximation can reduce the computational time dramatically.

To account for unobserved heterogeneity modeled as a finite mixture, I combine the sequential algorithm above and the expectation-maximization algorithm with a sequential maximization step developed by Arcidiacono and Jones (2003). Combining these algorithms makes the model estimation tractable. The details are described in Section B.2.

Because the computation of standard errors for the proposed algorithm is analytically complex, I take the converged estimates from this algorithm as a starting value for the full information maximum likelihood with the nested fixed-point algorithm.

5.2 Identification

In this subsection, I discuss identification issues. Although a formal identification argument may not be possible for a complicated structural economic model, an informal argument may help me understand what variations of the data identify which parameters along with parametric assumptions.

There are two policy variations in the data: changes in the eligibility condition and the replacement rate. Non-regular workers became eligible for mandated PL in 2005, which generates variation in the eligibility variable ELG_{it} (see Appendix A.1.1 for the precise definition). The variation in this variable helps me identify the effects of legal eligibility on the non-pecuniary utility from PL take-up, which is parameter $\nu_{l,3}$ in Equation (4).

Changes in the replacement rate affect consumption while on PL through the budget constraint. This variation identifies the marginal utility of consumption while staying at home or taking up PL, which is measured by parameter α_1 in Equation (1). For a greater value of the parameter α_1, women's PL take-up is more elastic to a change in cash benefits. Hence, the variation in PL cash benefits help me identify parameter α_1.

The intercepts of the non-pecuniary utility functions (Equations 3, 4, and 5) are time-invariant and vary by individuals. They are identified by the panel structure of the data. Given the parametric assumption that the intercepts are time-invariant, the remaining parameters in the non-pecuniary utility are identified by the variations of observed variables such as the age of the youngest child, number of children, and lagged decision variables. The heterogeneous intercept and lagged decision variable have similar effects on choice in the sense that both generate a serial correlation in choice, which can be seen in Table 4; however, they can still be distinguished. This is because the intercept is time-invariant and hence has permanent effects, while the effect of the lagged decision variable diminishes over time.

The intercepts of the earnings functions (Equations 6 and 8) are also time-invariant and vary by individuals. Similar to the argument above, they are identified by the panel structure of the data, while the remaining parameters are identified by variations in observed variables such as experiences.

One might consider the DID approach to be more suitable, at least for ex post policy evaluation, but it may not necessarily be superior to structural estimation in this context. In DID estimation, a researcher may consider that the treatment group comprises those in the eligible (i.e., regular) sector and the control group comprises those in the ineligible (i.e., non-regular) sector. However, this approach may result in a biased estimate because eligibility, or the worker's sector, is determined by past career decisions. In structural estimation, selection into sectors is modeled to avoid this bias.

Another reason why DID may not be a better method than structural estimation in this context is the small sample size. Because the employment rate prior to childbirth is low, the sample size for the DID approach is small, which results in imprecise estimates. The structural estimation approach avoids this problem by taking advantage of the economic model and knowledge about institutions. While misspecification of the structural model is a legitimate concern, I assess the model's internal validity by examining whether the model's predictions are consistent with some important features of the data. Of course, this is by no means a proof for identification; some of the assumptions may not be correct.

6 Estimation Results

6.1 Parameter Estimates

Marginal Utility of Consumption Table 6 reports the parameter estimates for the marginal utility of consumption. The estimated marginal utility of consumption is positive, but decreases when women work either in regular or non-regular sectors. This is consistent with the fact that a wife's labor force participation decreases with her husband's earnings, all else being equal. The estimates also indicate that the marginal utility of consumption increases with the number of children, which implies that labor supply increases with the number of children.

Table 6: Parameter Estimates for Marginal Utility of Consumption

	Estimate	S.E.
Home or On-Leave	0.074	0.013
Reg.	−0.030	0.006
Non-Reg.	−0.037	0.007
Sqrt. of No. Children	0.049	0.005

Non-Pecuniary Utility of Work There are two important findings from the estimates of the non-pecuniary utility of work shown in Table 7. First, the entry costs to employment sectors from home are large, which is particularly true for the regular employment sector. This is suggested by the large negative non-pecuniary utility of entering the regular sector from home (–4.755), which is the most negative of all factors in the model. The large entry cost implies that returning to work after quitting a job is difficult, and hence, job protection is expected to help mothers of young children return to the labor market quickly.

Second, having a young child decreases the non-pecuniary utility of work in both sectors, and the negative effect is particularly large when the child is less than 1 year of age. This is consistent with empirical evidence that maternal work in the first year of a child's life may have negative effects on both children and mothers themselves. Waldfogel, Han, and Brooks-Gunn (2002), Baum II (2003), and James-Burdumy (2005) find that maternal work during the first year of a child's life has a negative effect on the child's test scores. Baker and Milligan (2008b) find that maternal work can prevent breastfeeding, which improves the health of both children and mothers according to the World Health Organization.[16] Moreover, Wray (2011) argues that mothers need a year to fully recover from childbirth and be ready to work. If mothers care about the development of their children and their own health, and believe that maternal work has detrimental effects on these outcomes, the non-pecuniary utility from work will be very negative in the first year of the child's life.[17]

The large negative effect of a newborn on the non-pecuniary utility of work implies that PL is valuable for mothers of children aged less than one year because it allows them to be off work and stay with their new baby without losing their job. However, PL may not be as valuable for mothers of children aged one year or older because the negative effect on the non-pecuniary utility quickly fades after the child's first birthday. This difference between newborns and older children explains why one-year job protection increases female labor supply but expanding it to three years does not based on counterfactual simulations in Section 7.

Other estimates are also worth mentioning. As expected, the costs of returning from PL are small and not significantly different from zero in both sectors. The costs of switching between employment sectors are large, although they are smaller than the costs of entering from home. The unemployment rate is negatively related to the non-pecuniary utility of work in the regular employment sector, while it has almost no effect in the non-regular sector.

Transaction Cost of PL Take-Up The non-pecuniary utility of PL take-up varies greatly by unobserved type, as presented in Table 7: PL is generally unpleasant for type 1 women , but it is less so for other types. For type 1 women, the financial incentives of PL are likely to be irrelevant because of the large negative non-pecuniary utility of PL take-up. Legal eligibility for PL reduces the transaction cost of PL take-up, which is implied by its positive effects on non-pecuniary utility. Even though some employers grant PL voluntarily, mandating it can increase PL take-up. The transaction cost of PL take-up is also found to be lower in the regular sector than in the non-regular sector. This is because regular workers are more skilled and harder to find than non-regular

[16]World Health Organization recommends exclusive breastfeeding for the first six months.

[17] The literature does not fully agree on the effects of maternal work on child development. For example, using the changes in PL legislation, Baker and Milligan (2010, 2015) and Dustmann and Schönberg (2011) find no effects for Canada and Germany, while Carneiro, Løken, and Salvanes (2015) find negative effects of maternal work in Norway. In addition, Baker and Milligan (2008b) find no effects of breastfeeding on self-reported maternal and child health. Even if maternal work has no effect on these outcomes, mothers derive large negative utility from work if they believe it has detrimental effects.

Table 7: Parameter Estimates for Non-Pecuniary Utility from Labor Supply and Fertility Choices

	Reg.		**Non-Reg.**		**PL**		**Fertility**	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept (Type 1)	0.172	0.155	−0.115	0.144	−2.701	0.752	0.501	1.019
Intercept (Type 2)	−0.064	0.110	0.272	0.061	0.468	0.305	−0.753	0.319
Intercept (Type 3)	0.372	0.114	0.570	0.093	−0.810	0.346	0.354	0.301
Intercept (Type 4)	0.076	0.103	0.159	0.065	0.043	0.305	−0.098	0.321
Reg.							0.705	0.192
Non-Reg.							0.243	0.196
Lagged Home	−4.755	0.649	−2.611	0.352				
Lagged PL in Reg.	−0.292	0.230						
Lagged PL in Non-Reg.			0.349	0.437				
Lagged Reg. Empl.			−1.594	0.319	0.780	0.380		
Lagged Non-Reg. Empl.	−2.322	0.385						
PL Legally Eligible					1.388	0.407		
Lagged PL * Ineligible					0.788	0.390		
Sqrt. of No. Children	0.003	0.028	0.090	0.026			−0.594	0.368
Child Age 0	−2.614	0.396	−2.798	0.383			−0.361	0.439
Child Age 1	−0.080	0.180	−0.432	0.109			1.084	0.405
Child Age 2	−0.157	0.166	−0.498	0.106			1.235	0.398
Child Age 3-5	−0.081	0.074	−0.206	0.051			0.916	0.362
Child Age 6-11	−0.016	0.060	−0.139	0.047			0.295	0.339
Age							−0.059	0.042
Age-sq							−0.239	0.060
Unempl. Rate	−0.056	0.028	0.011	0.031				

workers, and hence, employers are more willing to offer additional PL to retain regular workers.

Utility from Children The last column in Table 7 reports parameter estimates for utility from children received as a lump sum at the time of conception. Utility decreases with the number of existing children and when the mother has a child aged less than one year. It also decreases with the mother's age at the quadratic rate.

Correlation Structure of Error Terms Table 8 presents the parameter estimates that govern the correlation structure of the error terms. The correlation of the error terms is modeled by the generalized nested logit. Four overlapping nests are constructed depending on the work and fertility alternatives (see Section 4.4 for details). Equation (22) in Appendix B.1 shows the choice probabilities using these parameters.

The dissimilarity parameters $\lambda_1, \ldots, \lambda_4$ measure the degree of independence among alternatives within the nest and take a value between zero and one. The estimates are smaller than one, implying that choices are correlated within each nest. The allocation parameter μ_b measures the extent to which an alternative is a member of nest b. The estimate is significantly above zero and below one, implying that the nests overlap. Ignoring this correlation structure, or the use of the multinomial logit model, biases the parameter estimates of the utility functions and can make unrealistic predictions arise from the assumption of independence from irrelevant alternatives.

Earnings Functions The parameter estimates for the earnings functions are shown in Table 9. For both the regular and non-regular sectors, experience in an individual's own sector increases earnings. Experience in the other sector also increases earnings, but at a lower rate than experience in one's own sector. Years at home reduce earnings in both sectors, which implies earnings capacity depreciates while at home or on leave. A temporary earnings penalty was also observed for those who stayed at home or had been on leave in the last year. New workers switching from the non-regular to the regular sector earn less than those already in the regular sector. By contrast, workers newly switching from the regular to the non-regular sector earn more than those already in the non-regular sector.

Husband's Earnings and Type Probability Functions The parameter estimates for the husband's earnings and type probability functions and the share of each unobserved type are reported in Appendix C, because they do not have structural interpretation.

Table 8: Parameter Estimates for Error Terms

	Estimate	S.E.
Dissimilarity Parameter		
λ_1	0.612	0.112
λ_2	0.810	0.129
λ_3	0.651	0.487
λ_4	0.927	0.228
Allocation Parameter		
μ_1	0.784	0.178

Note: Dissimilarity parameters measure the degree of independence among alternatives within the nest and take the value between zero and one. λ_1 is a dissimilarity parameter for the nest that includes alternatives for non-conception ($d_{f,it} = 0$) regardless of labor supply choices. λ_2 is for the nest that includes alternatives for conception ($d_{f,it} = 1$) regardless of labor supply choices. λ_3 is for the nest that includes alternatives for work ($d_{r,it} = 1$ or $d_{n,it} = 1$) regardless of fertility choices. λ_4 is for the nest that includes alternatives for non-work ($d_{h,it} = 1$ or $d_{l,it} = 1$) regardless of fertility choices. The allocation parameters measure the extent to which an alternative is a member of each nest. It is assumed that $\mu_1 = \mu_2$, $\mu_3 = \mu_4$, and $1 - \mu_1 = \mu_3$. See Equation (22) in Appendix B.1 for choice probabilities using these parameters.

6.2 Model Fit

I now present evidence on how well the model fits selected features of the data. I took the initial observations for each individual in the data, i.e., her employment and fertility choices, earnings, and earnings of her husband. I then ran 30 simulations using the model until the period ending with the last appearance of each individual in the data.

Figure 2 shows the observed and predicted age profiles of choice probabilities, her own and her husband's earnings, and the number of children. The solid lines are observed profiles and the dashed lines are predicted profiles. In all eight panels in the figure, the predicted age profiles are similar to the actual age profiles, although the profiles for both left and right tails are noisier because of the small sample size for these age groups.

Tables 10 and 11 show the model fit for employment transitions and PL take-up rates along with employment status around childbearing. For both sets of statistics, the model is able to predict the observed patterns in the data.

The model is identified by increases in the availability and generosity of Japan's PL policies as well as the parametric assumptions. Among the policy changes, the most notable is the expansion of job protection to non-regular workers in 2005. Table 12 presents how well the model fits selected features of the data before and after this major reform in 2005. The PL take-up rate among those

Table 9: Parameter Estimates for Log Earnings Functions

	Reg.		**Non-Reg.**	
	Estimate	S.E.	Estimate	S.E.
Intercept (Type 1)	−0.431	0.158	−2.459	0.066
Intercept (Type 2)	1.039	0.128	−1.356	0.061
Intercept (Type 3)	0.349	0.131	−0.623	0.059
Intercept (Type 4)	0.723	0.139	−0.021	0.061
Years in Reg.	0.030	0.006	0.023	0.002
Square of Years in Reg. / 100	−0.028	0.013		
Years in Non-Reg.	0.010	0.003	0.087	0.006
Square of Years in Non-Reg. / 100			−0.269	0.027
Years in Home	−0.025	0.017	−0.049	0.009
Square of Years in Home / 100	0.060	0.176	0.107	0.078
Lagged Home or On-Leave	−0.487	0.043	−0.677	0.020
Lagged Reg			0.165	0.054
Lagged Non-Reg.	−0.288	0.062		
Unempl. Rate	0.031	0.028	−0.006	0.012

Table 10: Model Fit for Transition Matrix

	Home	Reg	Non-Reg	PL
Data				
Home	0.886	0.010	0.104	0.000
Reg	0.066	0.826	0.038	0.071
Non-Reg	0.109	0.037	0.847	0.007
PL	0.103	0.653	0.122	0.122
Model				
Home	0.886	0.010	0.105	0.000
Reg	0.063	0.831	0.036	0.070
Non-Reg	0.111	0.038	0.844	0.007
PL	0.101	0.667	0.114	0.118

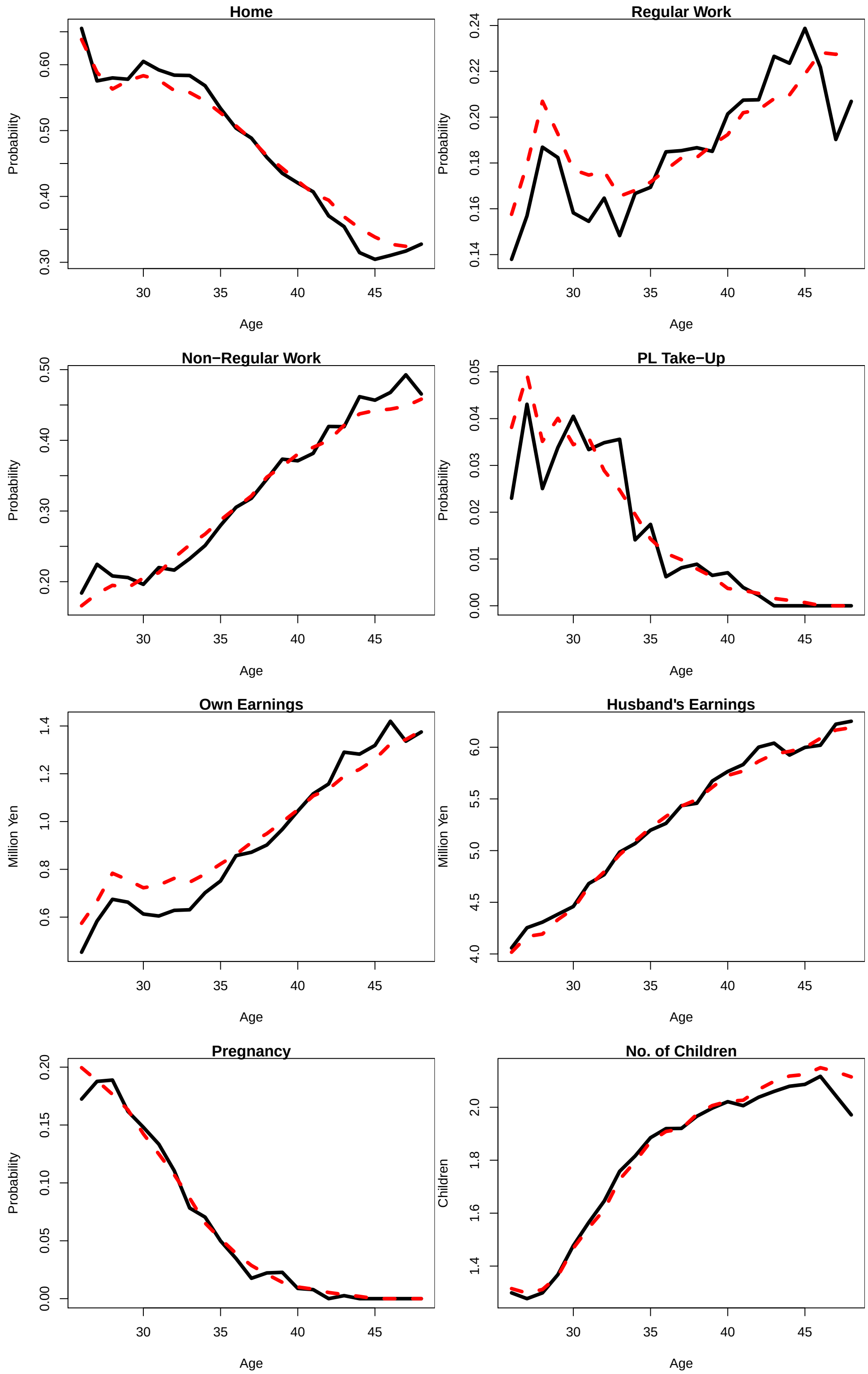


Figure 2: Age Profiles For Labor Market Outcomes
Note: The solid lines are observed profiles, while the dashed lines are predicted profiles.

Table 11: Model Fit for PL Take-Up Rate

	Data	Model
Among Those Who Give Birth		
(1) Eligible for PL	0.292	0.290
Among Those Who Are Eligible for PL		
(2) Quit and Stay Home	0.297	0.276
(3) Take Up PL	0.584	0.605
(4) Work	0.119	0.119
Among Those Who Took PL Last Year		
(5) Employed	0.897	0.899

who give birth increased from 0.140 to 0.249 after the reform, which is consistent with the expected effect of the PL reform. The model matches closely this increase in the PL take-up rate. The employment rate one year after PL take-up decreased slightly from 0.922 to 0.880, which is also well matched by the model. Because the 2005 reform is targeted at non-regular workers, the non-regular employment rate is expected to have increased after the reform; in fact, it increased from 0.088 to 0.160 in the data. The model's prediction closely tracks these changes.

Table 12: Model Fit for Employment Before and After the 2005 Reform

	Before 2005		**After 2005**	
	Data	Model	Data	Model
Among Those Who Give Birth				
Take Up PL	0.140	0.145	0.249	0.251
Among Those Who Took PL Last Year				
Employed in Any Sector	0.922	0.903	0.880	0.892
Employed in Non-Reg. Sector	0.088	0.066	0.160	0.177

6.3 Discussion

I have imposed several simplifying assumptions to make the model tractable for estimation. Two important assumptions are omitting saving decisions and taking husband's labor supply and earnings as exogenous. I cannot directly assess the potential costs of these assumptions because a more general model that relaxes these assumptions is intractable. However, I indirectly evaluate how these assumptions may result in biased estimates in a reduced-form fashion.

The model accounts for wealth effects through interactions between consumption and the labor supply and fertility choices because income, consumption, and wealth are positively correlated. To see if assets have an additional explanatory power for labor supply and fertility choices, I regress dummy variables for these choices on assets and state variables used in the model (see the note to Table 13 for a list of explanatory variables) using a linear probability model.

The regression results are presented in Table 13. Assets add very little to explanation of the probabilities of choosing to stay at home, working in regular and non-regular sectors, and childbearing, as indicated by the insignificant p-values for the assets variable. However, assets are significantly correlated with the PL take-up rate, the p-value being 0.001. The results suggest that assets are an important predictor for PL take-up, but not for other employment choices and fertility decisions.

Table 13: Correlation Between Asset and Employment and Fertility Outcomes

	Home	Regular	Non-Regular	PL	Childbearing
Coefficients					
Asset	0.041	-0.007	-0.047	0.013	9.37e-18
	(0.030)	(0.019)	(0.030)	(0.009)	(1.29e-16)
Asset-Sq.	-0.020	0.005	0.033	-0.018	-1.10e-18
	(0.023)	(0.015)	(0.023)	(0.007)	(9.95e-17)
Significance					
F-statistic	1.625	0.060	1.262	6.663	0.015
p-value	0.197	0.942	0.283	0.001	0.985

Note: Assets are measured in 100 million JPY (≈1 million USD). Using a linear probability model, dummy variables for employment and fertility choices are regressed on asset, asset squared, education, age in the first year in the survey, current age, experiences in regular and non-regular sectors, years at home, lagged employment choices, eligibility for PL, square of children, age of the youngest child, husband's earnings, and unemployment rate. F-tests are conducted to assess the joint significance of asset and asset squared.

The model takes husband's labor supply and earnings as exogenous but ignores a possible joint labor supply response by wives and husbands to the policy changes in PL. I informally assess the extent of the responsiveness of husband's labor supply to a policy change by examining selected labor market outcomes for husbands before and after the major PL reform in 2005.

The first column of Table 14 shows that the level of labor supply for married men is very high throughout the sample period. Because the JPSC asks the husband's weekly hours of work by an interval scale, and the lowest interval is between 0 and 15 hours, I calculate the percentage of husbands who work 15 or fewer hours per week instead of the employment rate. I also calculate weekly hours of work by converting an interval scale into a continuous scale and report mean annual earnings.

Table 14: Husband's Labor Supply and Earnings

	1994-2011	Before 2005	After 2005
Work 15 or Fewer Hours Per Week	0.008	0.008	0.008
Average Hours/Week	51.580	51.845	51.175
Annual Earnings (in mil. JPY $\approx$ 10,000 USD)	5.205	5.112	5.328

Source: JPSC

Columns 2 and 3 of Table 14 show how these labor market outcomes changed after the 2005 PL reform. The percentage of husbands working 15 or fewer hours per week did not change. Average weekly hours of work decreased slightly from 51.845 to 51.175, while average annual earnings increased slightly from 5.112 to 5.328. These changes may reflect husbands' responses to the PL reform, but they are modest compared with large changes in mothers' PL take-up and non-regular employment rates. The exercises here are by no means proof of exogeneity of husbands' labor supply, but they provide somewhat useful information for assessing the consequences of the assumption, and seem to suggest that modeling husbands' labor supply is not quantitatively important.

7 Counterfactual Simulations

Using the estimated model, I simulate labor supply and fertility decisions of women under different policy scenarios. In each hypothetical scenario, a new policy is legislated and enforced in 2010 in order to preclude announcement effects. No further PL reforms take place, which is known to individuals.

In evaluating policies, I simulate those women who were pregnant and worked in 2009 because they are most directly affected by a policy change in 2010. Each individual is simulated 1,000 times.

7.1 Job Protection

Three policy scenarios are simulated: (1) no PL, (2) one-year job protection, and (3) three-year job protection. In all scenarios, no cash benefits are paid. The results do not change qualitatively regardless of the arrangement of cash benefits. I simulate different durations of job protection by changing the legal eligibility requirement for PL. For one-year job protection, individuals must have been employed during the previous year and their youngest child must be less than one year of age. For three-year job protection, the age requirement is relaxed so that the youngest child must be two years of age or less, which allows a woman to take job-protected leave for three years at most. See Appendix A.1.1 for the precise definition of the variable for PL eligibility, ELG_{it}.

Simulated responses are graphically presented in Figure 3.[18] Panel (a) shows the probability of work. The probability of work in the childbearing year drops to 0.19 without mandated PL. It is lower under one- or three-year job protection because more women are on leave. Mothers gradually return to work after childbearing. The probability of work one year after childbearing is 0.33 without mandated PL. Under one- and three-year job protection, this increases to 0.54. These policy effects on maternal work persist as long as 10 years after childbearing. One- and three-year job protection increase the probability of work 10 years after childbirth from 0.58 to 0.66 and 0.67, respectively. Note that policy effects are similar for one- and three-year job protection, which implies that expanding job protection from one to three years has little marginal effect.

Panel (b) shows PL take-up rates. Even if PL is not mandated, the take-up rate is 0.12 in the year of childbearing because some employers voluntarily offer job-protected PL. One- and three-year job protection boost take-up rates by more than four times. However, the take-up rates a year after childbearing drop substantially, although it is higher under three- than under one-year job protection. The results indicate that most women take PL for just one year, even if PL is available for three years, which explains why expanding job protection from one to three years has little marginal effect on maternal work.

Panels (c) and (d) show the proportion of mothers working in the regular and non-regular employment sectors, respectively. Job protection increases the percentage of mothers working in the regular sector, and the policy effects persist 10 years after childbirth. By contrast, job protection slightly decreases the proportion of mothers working in the non-regular sector. These results indicate that the rise in the probability of work is mostly because of the rise in the percentage of mothers working in the regular sector. These differential effects between sectors are consistent with the observation that the entry cost from home is higher for the regular than for the non-regular sector.

Panels (e) and (f) show the probability of pregnancy and the number of children, respectively. The probability of pregnancy rises to 0.13–0.16 at one year after childbearing and then decreases. It varies little between policies, although more generous job protection increases fertility. The number of children in year 10 is 2.10 without job protection. This increases to 2.15 and 2.20 when one- and three-year job protection is mandated. Thus, job protection appears to have a small positive effect on fertility.

Policy effects on accumulated income, accumulated consumption, and welfare are also eval-

[18] Detailed simulations results are available in Tables 22 and 23 in Appendix C.

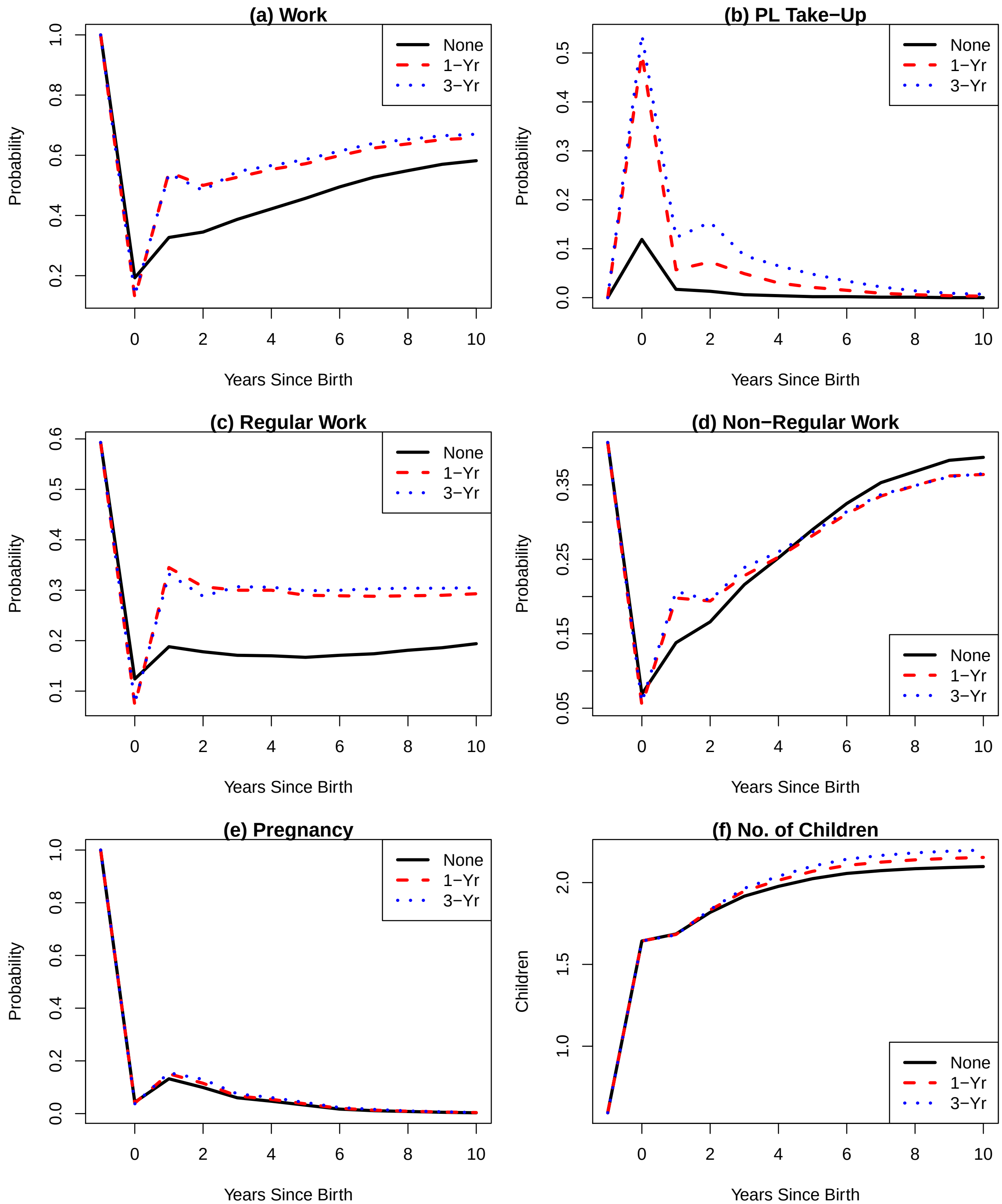


Figure 3: Effects of Job Protection

Table 15: Effects of Parental Leave Policies on Accumulated Income, Consumption, and Welfare

	Income	Consumption	Utility (Rank)
(1) JP:0, RR:0%	10.56	74.39	16.38 (9)
(2) JP:1, RR:0%	14.81	77.77	16.86 (6)
(3) JP:3, RR:0%	14.88	77.77	17.11 (3)
(4) JP:0, RR:50%	10.11	75.68	16.49 (7)
(5) JP:1, RR:50%	15.1	79.99	17.01 (4)
(6) JP:3, RR:50%	15.21	80.08	17.27 (1)
(7) JP:0, RR:50% + Need to Take PL	11.07	75.27	16.4 (8)
(8) JP:1, RR:50% + Need to Take PL	15.68	80.02	16.97 (5)
(9) JP:3, RR:50% + Need to Take PL	15.6	80.04	17.24 (2)

Note: JP and RR stands for job protection and replacement rate of cash benefits, respectively. The label "Need to Take PL" in rows 7-9 means that a mother must take up a job protected PL to receive cash benefits. Income and consumption are the present values of labor income and consumption streams for 15 years since childbearing. The discount rate is 5% per annum. Utility is the present value of life-time utility and given by the value function.

uated and presented in the first three rows of Table 15. Income and consumption are the present values of women's labor income and household consumption streams for 15 years since childbearing. Utility is the present discounted value of lifetime utility given by the value function. The discount rate is 5% per annum. The introduction of one-year job protection increases accumulated income from 10.56 to 14.81 or by 40% (see rows 1 and 2). It also increases accumulated consumption from 74.39 to 77.77. In terms of the rate of change, this is a modest increase of 5%, because mother's earnings are a small share of total household income. The introduction of one-year job protection and its expansion to three years increase welfare in the model because by construction, these policies have no side effects.

The simulation results indicate that although introducing one-year job protection significantly increases maternal work after childbearing, expanding job protection from one to three years has little effect. As shown in Table 7, the non-pecuniary utility of work is a large negative when the youngest child is less than one year of age. When job-protected leave is not mandated, new mothers quit their jobs because of the large negative non-pecuniary utility of work. They return to the labor market after childbearing, but the pace is slow owing to the high entry costs. The introduction of one-year job protection allows women to take PL when the non-pecuniary utility of work is a large negative. They can return to the labor market after childbearing at a faster pace because they do not pay that high entry cost. When a child grows older one year of age, the non-pecuniary utility of work is still negative, but much smaller than that for a mother of a newborn. Hence, most women return to work at one year after childbearing even if they can take PL for three years.

7.1.1 Ex Ante Evaluation of PL Reform Proposed by Prime Minister Abe

Japanese Prime Minister Abe proposed a PL reform to raise the labor force participation rate of mothers of young children. Under the legislation at the time (April 2013), the duration of job protection was one year, the replacement rate of the cash benefit was 50%, and mothers had to take up job-protected PL to receive cash benefits. Prime Minister Abe proposed to extend job protection to three years without changing the arrangement for cash benefits. His proposal initiated a heated policy debate, and although it has not been legislated as at the writing of this paper, the likely outcomes of the policy reform remain poorly understood. The structural estimation approach taken in the present paper is suitable to assess the potential effects of the proposed reform before its implementation.

Table 16: Ex Ante Evaluation of PL Reform Proposed by Prime Minister Abe

	Mean	**Policy Effects**
	1Yr + 50% + 'Need to Take PL'	1Yr + 50% + 'Need to Take PL' $\rightarrow$ 3Yr + 50% + 'Need to Take PL'
On PL in $t = 0$	0.54	0.03
Work in $t = 5$	0.59	0.01
Earnings in $t = 5$	1.48	-0.02
No of Children in $t = 10$	2.18	0.05

Note: The first column labeled as "Mean" shows mean of outcomes variables before the PL reform. The second column labeled as "Policy Effects" shows the mean changes of outcomes variables caused by the PL reform.

Table 16 summarizes the main simulation results.[19] As expected from the previous simulations, the policy reform will not have sizable effects on maternal work or fertility. Table 15 presents the policy effects on accumulated income, consumption, and welfare (see rows 7 and 8). The expansion improves these outcomes modestly.

The main limitation of these simulations is that they are a partial equilibrium analysis. Although cash benefits are paid by employment insurance, not by employers, mandating three-year job protection may be costly for employers. This is because employers may have to hire additional workers or temporarily re-assign existing workers to undertake the tasks of the PL takers while they are on leave. Hence, PL reform is likely to decrease the demand for female workers of childbearing age. The partial equilibrium analysis assumes that the demand stays the same after the policy reform, which implies that the simulations provide upper bounds for labor market outcomes. In

[19]The full results are available in Tables 22 and 23 in Appendix C.

conclusion, the proposed reform is unlikely to improve mothers' labor market outcomes.

7.1.2 Role of Human Capital Depreciation

In this subsection, I examine how policy effects would change if human capital did not depreciate while staying at home or being on leave. Human capital depreciation affects the opportunity cost of taking PL, which may explain why the extension of job protection from one to three years does not increase maternal employment.

Table 17: Policy Effects Under Different Setup

	Mean	Policy Effects		
	(1) Before Change	(2) Baseline	(3) No HC Depreciation	(4) Low Entry Cost
No PL → 1-Yr JP (w/ No Benefit)				
On PL in $t = 0$	0.12	0.38	0.38	0.30
Work in $t = 5$	0.46	0.11	0.13	0.02
Earnings in $t = 5$	0.87	0.51	0.65	0.14
No of Children in $t = 10$	2.10	0.06	0.08	0.05
1-Yr JP → 3-Yr JP (w/ 50% + PL Take-Up)				
On PL in $t = 0$	0.54	0.03	0.03	0.04
Work in $t = 5$	0.59	0.01	0.00	−0.01
Earnings in $t = 5$	1.48	−0.02	0.00	−0.03
No of Children in $t = 10$	2.18	0.05	0.06	0.03

Note: Column (1) shows mean of outcomes variables before the PL reforms. Columns (2)-(4) show the mean changes of outcomes variables caused by the PL reforms under different assumptions. JP stands for job protection.

Two policy changes are simulated. In the first, one-year job protection is first introduced, but no cash benefits are paid. In the second, job protection is extended from one to three years, as in Section 7.1.1, in which the replacement rate of cash benefits is at 50% and cash benefits are paid only when an individual takes PL.

The policy effects of the baseline model are compared with the model without human capital depreciation. In the baseline model, all parameters are at the estimated values. In the model without human capital depreciation, the coefficients for years at home and lagged sectors in the earnings functions (6) are set to zero.

In Table 17, Column (2) shows the policy effects in the baseline model, while Column (3) shows those when human capital does not depreciate. Although the policy effects are stronger when human capital does not depreciate, they are similar to those of the baseline model. Hence, human capital depreciation does not explain why most women do not take PL for three years, even when three-year job protection is possible.

The estimates in Table 9 indicate that one year spent at home decreases earnings by 2 to 5%, which may not be large enough to prevent women from taking PL for an extended period. Human capital depreciation may be crucial for highly skilled women, but it does not seem so for women of average skill. Indeed, only 14% in the sample graduated from a four-year university. It should also be noted that this result is consistent with previous findings in other countries. For example, Lalive, Schlosser, Steinhauer, and Zweimüller (2014) find no evidence for human capital depreciation among the group of mothers exposed to longer leave regimes.

7.1.3 The Cost of Entry and Job Protection Policy

The simulation indicates that the effect of job protection is concentrated in the regular sector and lasts for several years after childbirth. This is because the cost of entry to regular employment from home is high.

To see how entry costs influence the effects of job protection, I simulate the model under the assumption that the entry costs are reduced by 50%. I compare that with the results from the last subsection 7.1.2, presented in Table 17.

As expected, lower entry costs weaken the policy effects on maternal work relative to the baseline model. This implies that differences in labor market friction and/or flexibility between countries must be taken into account when one tries to generalize the findings of this paper. Lin and Miyamoto (2012) find that the monthly job finding and separation rates in Japan are about 14% and 0.4%, respectively, while they are 25–32% and 3–5% in the US, according to Yashiv (2008). These statistics suggest both that the labor market is more flexible and that the entry cost is smaller in the US compared with Japan, and hence, the employment effect of job protection is also expected to be smaller.

7.2 Cash Benefits

I evaluate the effects of PL cash benefits by simulating three scenarios where the duration of job-protected PL is one year. In the first scenario, no cash benefits are paid. In the second, unlike the actual legislation in Japan, mothers can receive cash benefits even if they do not apply for job-protected PL. This scenario tries to replicate the PL system seen in other countries such as Canada and Germany. In the third, mothers must apply for job-protected PL to receive cash benefits, which corresponds to the current Japanese PL system. In the second and third scenarios, the replacement rate is set at 50%.

These scenarios are implemented as follows. In the first scenario, the replacement rate of the cash benefit is set to zero. In the second, cash benefits are paid to women who (1) give birth, and (2) have worked in the previous year before childbirth, but they do not have to take up job-protected PL. The third scenario uses the estimated baseline model that imitates the actual legislation. In the baseline model, to be eligible for cash benefits, a mother must apply for job-protected PL. To be eligible for job-protected PL, she must satisfy the following two conditions: (1) the age of the youngest child is zero, and (2) she has been employed without being on any form of leave, in the eligible sector in the previous year.

Cash benefits are expected to increase the number of mothers staying at home in the short run, but the long-run effects on maternal work are ambiguous. On the one hand, cash benefits may increase maternal work because women want to become eligible for cash benefits. On the other hand, cash benefits may decrease maternal work because mothers lose their human capital while on PL. Whether cash benefits are tied to job-protected PL also matters to their labor supply after childbearing. If mothers are required to take up job-protected PL to be eligible for cash benefits, then cash benefits increase the incentive to take up PL, which helps women to return to work.

Table 18: Marginal Effects of Cash Benefit Arrangement

	Mean	**Policy Effects**	
	No Benefit	0%→50%	50%→ 50% + 'Need to Take PL'
On PL in $t = 0$	0.50	0.02	0.02
Work in $t = 5$	0.57	0.01	0.01
Earnings in $t = 5$	1.38	0.03	0.06
No of Children in $t = 10$	2.15	0.03	0.00

Note: The following three scenarios are simulated. In the first scenario, no cash benefit is paid. In the second scenario, mothers can receive cash benefit even if they do not apply for a job protected PL. In the third scenario, mothers must apply for a job protected PL to receive cash benefit. In the second and third scenarios, the replacement rate is set at 50%. The first column labeled as "Mean" shows mean of outcomes variables when no cash benefits are paid (the first scenario). The second column shows the effects of a change from the first to second scenarios, while the third column shows the effects of a change from the second to the third scenarios.

Table 18 summarizes the simulation results.[20] The effects on the PL take-up rate are modest. The first column shows the mean outcomes in the first scenario in which no cash benefits are paid. The second column shows the effects of a change from the first to second scenarios, while the third column shows the effects of a change from the second to the third scenarios. When the replacement rate increases from 0% to 50%, the take-up rate increases by two percentage points. When cash benefits and job-protected PL are tied together, the take-up rate further increases by two percentage points. The effects on probability of work, earnings, and fertility are also modest, although positive. These results are in line with Asai (2015), who estimates the effects of cash benefits using the DID approach and finds that they have little effect on employment in Japan.

[20]Detailed results are available in Appendix C.

Effects on accumulated income, accumulated consumption, and welfare are presented in Table 15 (see rows 2, 5, and 7). Raising the replacement rate from 0% to 50% improves accumulated income, consumption, and welfare. Tying cash benefits to job-protected PL increases income and consumption but decreases welfare for lost time at home. Yet, tying cash benefits to job-protected PL is preferred over no cash benefits.

7.3 Other Family-Friendly Policies

PL is not the only family-friendly policy that might be expected to affect women's labor supply and fertility behavior. The simulation results above indicate that PL policies generally have only modest effects on fertility, but large financial incentives directly targeted at fertility may increase the fertility rate.

To assess the effects of baby bonuses, I simulate the model in which 1, 3, and 5 million JPY (≈ 10,000, 30,000, and 50,000 USD, respectively) are paid at childbirth. I fix the PL policies at the 2011 level so that one-year job protection is available for both the regular and non-regular sectors, the replacement rate of cash benefits is 50%, and cash benefits are paid only when an individual takes up job-protected PL.

Table 19: Effects of Baby Bonus and Childcare Subsidy

	Baseline	**Baby Bonus**			**Free Childcare**
		1 Mil. JPY	3 Mil. JPY	5 Mil. JPY	
On PL in $t = 0$	0.54	0.54	0.55	0.55	0.56
Work in $t = 5$	0.59	0.59	0.58	0.57	0.63
Earnings in $t = 5$	1.48	1.47	1.45	1.44	1.62
No of Children in $t = 10$	2.18	2.23	2.34	2.46	2.20

Note: In the baseline simulation, the PL policies in 2011 are adopted. Namely, 1-year job protection is available for both regular and non-regular sectors, the replacement rate of cash benefit is 50%, and cash benefits are paid only when an individual takes up a job protected PL. Baby bonuses of 1, 3, and 5 million yen (≈10,000, 30,000 and 50,000 USD) are paid at childbearing. The childcare subsidies cover the full cost of childcare and parents do not pay any childcare fees.

The simulation results are presented in Table 19. The first column shows simulation results for the baseline model in which no baby bonuses are paid. The second to fourth columns show simulation results for the baby bonuses of 1, 3, and 5 million JPY, respectively. The results indicate that baby bonuses increase the fertility rate and that policy effects increase with the size of the bonus. Namely, the baby bonus of 5 million JPY increases the fertility rate from 2.18 to 2.46.

However, the downside of the large baby bonus is that it also decreases the mother's labor supply and earnings: the baby bonus of 5 million JPY decreases the probability of work and earnings five years after childbearing from 0.59 to 0.57 and from 1.48 to 1.44, respectively. This side effect is a logical consequence of increased fertility: baby bonuses increase fertility, and hence, eventually increase the pecuniary and non-pecuniary costs of labor supply.

PL legislation generally has few fertility effects, even though it increases mothers' labor income and household consumption substantially. For example, changing from no PL to one-year job-protected PL increases the present value of consumption by 3.38 million JPY (see Table 15). While this increase is comparable to the baby bonus of 3 million JPY, PL and the baby bonus have very different effects on fertility and maternal employment. The simulation results suggest that there is a fundamental trade-off between a woman's career and children, and that promoting both at the same time is quite challenging for policy makers. Job-protected PL increases mother's employment and hence her human capital by removing the cost to reenter the labor market after leave, but holding a job and having more human capital increases the opportunity cost of having an additional child. By contrast, baby bonuses raise fertility, but also have a slightly negative effect on mother's labor supply. This is because having a child increases the pecuniary and non-pecuniary costs of her labor supply.

Another family-friendly policy that may promote both fertility and mother's work is a childcare subsidy. However, assessing the effects of a childcare subsidy in the Japanese context is not straightforward in the current model for two reasons. First, the model does not allow for the use of free or cheap informal childcare arrangements provided by grandparents. Yamaguchi, Asai, and Kambayashi (2018) report that about 10–20% of working mothers of children aged 1.5–3.5 years take advantage of care by grandparents. For mothers using free childcare, the current model overestimates the cost of work. Second, many Japanese parents are unable to find a slot in formal childcare centers because the supply of formal childcare falls short of the demand in large cities such as Tokyo. For mothers who cannot find a slot, the effective childcare price is infinite; the current model cannot capture this feature.

Despite these limitations, to assess the role of financial cost in young mother's labor supply, I conducted counterfactual simulations in which childcare is fully subsidized and parents pay no childcare fees. The simulation results are presented in the fifth and last columns. Childcare subsidies modestly increased both fertility and mother's labor supply. The effect of providing free childcare is modest because childcare is already heavily subsidized; hence, the policy change does not provide a large additional financial incentive. Yamaguchi, Asai, and Kambayashi (2018) point out that providing more childcare slots instead of reducing the childcare fee has large positive employment effects on mothers of children aged one to two years.

8 Conclusion

In the present paper, I constructed and estimated a dynamic discrete choice structural model of female employment and fertility decisions. My contribution is to model job protection and cash benefits of parental leave. Job protection allows women to return to work after childbearing without paying entry costs to employment, while cash benefits provide financial incentives to take up parental leave.

The model is estimated by the sequential estimation algorithm based on Kasahara and Shimotsu (2011) and the EM algorithm of Arcidiacono and Jones (2003). The sieve approximation for the value function of Arcidiacono, Bayer, Bugni, and James (2013) is also applied to further reduce computational burden. As far as I know, this paper is the first application that combines these three methods. The estimated model seems to fit selected features of the data.

The model is used to conduct counterfactual simulations for evaluating parental leave policies. Effects of one-year job protection on maternal work are significant, but extending the duration of job protection from one to three years has little effect. This is because the non-pecuniary utility of work is very negative only in the first year of a child's life.

Evidence suggests that the large negative non-pecuniary utility of work for mothers of newborns is not specific to Japanese women, but policy effects may depend on labor market institutions. The effect of job protection tends to be strong when the cost of entry to the labor market is high, and hence, job protection may have smaller employment effects in the US, where the labor market is significantly more flexible than in Japan.

Nevertheless, the model and estimation method offer a useful tool to predict the potential effects of parental leave in other countries such as the US, where the FMLA offers only 12 weeks of unpaid parental leave. The model could be used to conduct an ex ante evaluation of extending the job protection period and the introduction of cash benefits.

One area to examine in future work is the interaction with other pro-family policies intended to support working mothers, such as childcare expansion. Such policies are likely to affect the cost of children for labor force participation, and hence, the effects of parental leave policies.

A Details of Data

A.1 Variable Definitions

A.1.1 Eligibility Status for Parental Leave

Eligibility for mandated PL is determined by the age of the youngest child, lagged employment sector, and calendar year. Specifically, the legal eligibility status ELG_{it} is given by

$$ELG_{it} = \begin{cases} 1 & \text{if } (a_{k,it} = 0, e_{r,it-1} = 1) \text{ or } (a_{k,it} = 0, e_{n,it-1} = 1, t \geq 2005) \\ 0 & \text{otherwise.} \end{cases}$$

Remember that one can take PL if the child is less than age one and the PL taker was employed in the eligible sector in the prior year. The regular sector is the eligible sector throughout the period of analysis, while the non-regular sector became an eligible sector since 2005.

In the counterfactual simulations in Section 7, one can take PL for three years in both regular and non-regular sectors. In the simulation of three-year job protection, the legal eligibility status ELG_{it} is redefined as

$$ELG_{it} = \begin{cases} 1 & \text{if } (a_{k,it} \leq 2, e_{r,it-1} = 1) \text{ or } (a_{k,it} \leq 2, e_{n,it-1} = 1) \\ 0 & \text{otherwise.} \end{cases}$$

A.1.2 Labor Market Status

The choice variable for labor market status has four possible, mutually exclusive states. It is determined by the following hierarchical rule. First, I determine if a woman is on parental leave. If not, I examine whether she works in the regular or non-regular sector. If she is not on leave or does not work, I consider she stayed at home.

Parental Leave Take-Up For those who report childbearing, JPSC asks whether an individual took a PL or not. If yes, she is considered on PL for the year. If not, I check her employment status as of October and whether she had a baby. The employment status as of October includes information on whether the respondent is on PL or not, but this answer alone does not seem reliable. Women are considered on PL, if they (1) give birth and (2) are on PL or leave other than parental, caregiving, and medical leave as of October.

A woman may be on PL even when she does not deliver a baby, because the leave can be for older children. To determine if their reported PL is correct, I check if they have a child and the age of the youngest child. Ten women report PL as of October, but they have no child. These respondents seem to be on pregnancy leave, because they had a baby in the next year. They are not considered to be on PL.

For those who have a child and report PL, the age of the youngest child is four or less. For those who have a child aged four, the reported PL seems false, because they have a baby in the following year and the child is too old for a PL. They are likely to be on pregnancy leave, not on PL. For two out of three women who have a child age three, the reported PL seems false for the same reason as above. One exception is the woman with ID number 766, who does not deliver a baby in the following year and works full-time for the whole year. I consider her PL is true. For those who have children aged one or two, I consider their reported PL is all true, because the child is reasonably young for PL and they report PL in the previous year.

Work in the Regular and Non-Regular Employment Sectors If a woman is considered not on PL according to the criteria above, I determine if she works in the regular or non-regular sector. If a woman works as a regular or non-regular employee as of October, I consider that she works in the reported employment sector for the year. If a woman is employed, reports PL or leave other than parental (caregiving,or medical) and gives birth in the next year, she is considered to work in her reported employment sector. This is because she is likely to be on short pregnancy leave in October and work most of the year.

Stay at Home If a woman is considered not on PL and not at work according to the criteria above, I determine if she stays at home. If a woman was on some kind of leave, a homemaker, or did not do any work as of October, she is considered to stay at home.

A.1.3 Sector-Specific Experiences

Retrospective labor market status from age 18 is available for the 1997 and newer cohorts in the year they first appear in the survey. It is also available for the 1993 cohort in 1997. Part-time job, dispatched work, and minor paid-work at home are all considered as the non-regular work. The labor market status constructed subsection A.1.2 is used to construct the sector specific experiences for years when individuals are surveyed. Years stayed at home is topcoded at ten.

A.1.4 Other Variables

Childbearing is identified if an individual reports that she had a baby or if the reported age of the youngest child is zero. In constructing the number of children and the age of the youngest child, I count all children regardless of whether they live with the survey respondent. This is relatively innocuous, because most children age ten or younger live with their mothers. Years of education is constructed from the completed education level. Junior high-school is nine years, high school is 12 years, two-year college and vocational school are 14 years, four-year university is 16 years, and advanced degree is 18 years. Finally, own and husband's labor income are deflated by the 2010 CPI.

B Details of Model Estimation

This subsection explains the estimation of the structural model. In subsection B.1, I define the likelihood function. In subsection B.2, I describe the estimation algorithm.

B.1 The Likelihood

Define d_i as a sequence of choices made by individual i from $\tau(i)+1$ to T_i where $\tau(i)$ and T_i are the first and last years when individual i is observed in the data, respectively, i.e., $d_i = (d_{i\tau(i)+1}, d_{i\tau(i)+2}, \cdots d_{iT_i})$. Sequences of own and husband's (male spouse's) earnings are similarly defined and given by y_i and $y_{m,i}$, respectively. Let $\theta = (\theta_1, \cdots, \theta_K)$ be a vector of parameters for all K types where θ_k is a vector of parameters for type k. Let $\pi = (\pi_1, \cdots, \pi_K)$ be a vector of parameters for type probability. Define $z_{i\tau(i)}$ as a vector of observed characteristics and choice in year $t = \tau(i)$: $z_{i\tau(i)} = (d_{i\tau(i)}, S_{i\tau(i)}, edu_i)$ where edu_i is years of education. The likelihood of observed sequences of choices, own earnings, and husband's earnings conditional on $z_{i\tau(i)}$ is

$$\begin{aligned} & \mathscr{L}(d_i, y_{m,i}, y_i \mid z_{i\tau(i)}; \theta, \pi) \\ = & \sum_{k=1}^{K} p_k(z_{i\tau(i)}; \pi) L(d_i, y_{m,i}, y_i \mid d_{i\tau(i)}, S_{i\tau(i)}; \theta_k), \end{aligned} \tag{12}$$

where $p_k(\cdot)$ is the probability of being type k and $L(\cdot|\cdot;\theta_k)$ is the conditional likelihood of the sequences given being type k and the observed choices and state variables in the first year (i.e. $t = \tau(i)$).

Given the first order Markov structure of the model, the likelihood of the observed sequences can be rewritten as a product of probability functions. The parameter vector for type k consists of the sub-parameter vectors such that $\theta_k = (\theta_k^y, \theta_k^{ym}, \theta_k^u)$, where θ_k^y is a parameter vector for own earnings functions, θ_k^{ym} is a parameter vector for husband's earnings function, and θ_k^u is a parameter vector for the utility function

$$
\begin{aligned}
& L(d_i, y_{m,i}, y_i \mid d_{i\tau(i)}, S_{i\tau(i)}; \theta_k) \\
= & \prod_{t=\tau(i)+1}^{T_i} l(d_{it}, y_{m,it}, y_{it} \mid S_{it-1}, d_{it-1}; \theta_k) \qquad (13) \\
= & \prod_{t=\tau(i)+1}^{T_i} l^d(d_{it}|S_{it}; \theta_k^d, \theta_k^y, \theta_k^{ym}) \cdot l^y(y_{it}|S_{it}, d_{it}; \theta_k^y) \cdot l^{ym}(y_{m,it}|S_{it-1}, d_{it-1}; \theta_k^{ym}), \qquad (14)
\end{aligned}
$$

where $l^d(\cdot)$ is the conditional choice probability given the structural model and state variables in year t, $l^y(\cdot)$ is the likelihood of earnings given the state variables and choice in year t, and $l^{ym}(\cdot)$ is the conditional likelihood for earnings of husband in year t given the choice and state variables in the previous year $t-1$, respectively,

The likelihood for individual's own and her husband's earnings is straightforward. Let $\hat{y}_{it}$ and $\hat{y}_{m,it}$ be the predicted values for y_{it} and $y_{m,it}$, respectively. The likelihood for y_{it} and $y_{m,it}$ is given by

$$
\begin{aligned}
l^y(\ln y_{it}|S_{it}, d_{it}; \theta^y) &= \phi((\ln y_{it} - \widehat{\ln y_{it}})/\sigma_y)/\sigma_y \qquad (15) \\
l^{ym}(y_{m,it}|S_{it}, d_{it}; \theta^{ym}) &= \phi((y_{m,it} - \hat{y}_{m,it})/\sigma_m)/\sigma_m, \qquad (16)
\end{aligned}
$$

where $\phi(\cdot)$ is the density function for the standard normal distribution and σ_y and σ_m are standard deviations. Note that I model the level, not log, of the husband's earnings to allow for the value zero.

Next consider the likelihood for employment and fertility choices. The choice-specific error term $\varepsilon_{j,it}^f$ follows a generalized extreme distribution so that error terms may be correlated with each other. Specifically, I use the generalized nested logit model that allows for overlapping nests (see Wen and Koppelman (2001)). There are four nests of alternatives labeled, $B_1, \cdots, B_4$. Nest B_1 includes alternatives for non-conception ($d_{f,it} = 0$) regardless of labor supply choices, nest B_2 includes alternatives for conception ($d_{f,it} = 1$) regardless of labor supply choices, nest B_3 includes alternatives for work ($d_{r,it} = 1$ or $d_{n,it} = 1$) regardless of fertility choices, and nest B_4 includes alternatives for non-work ($d_{h,it} = 1$ or $d_{l,it} = 1$) regardless of fertility choices. Formally, the nests are defined as

$$
\begin{aligned}
B_1 &= \{(d_{h,it} = 1, d_{f,it} = 0), (d_{r,it} = 1, d_{f,it} = 0), (d_{n,it} = 1, d_{f,it} = 0), (d_{l,it} = 1, d_{f,it} = 0)\} \qquad (17) \\
B_2 &= \{(d_{h,it} = 1, d_{f,it} = 1), (d_{r,it} = 1, d_{f,it} = 1), (d_{n,it} = 1, d_{f,it} = 1), (d_{l,it} = 1, d_{f,it} = 1)\} \qquad (18) \\
B_3 &= \{(d_{r,it} = 1, d_{f,it} = 0), (d_{n,it} = 1, d_{f,it} = 0), (d_{r,it} = 1, d_{f,it} = 1), (d_{n,it} = 1, d_{f,it} = 1)\} \qquad (19) \\
B_4 &= \{(d_{h,it} = 1, d_{f,it} = 0), (d_{l,it} = 1, d_{f,it} = 0), (d_{h,it} = 1, d_{f,it} = 1), (d_{l,it} = 1, d_{f,it} = 1)\} \qquad (20)
\end{aligned}
$$

Denote by $\bar{V}_j^f(S_{it})$ the choice-specific value less the preference shock $\varepsilon_{j,it}^f$ such that

$$\bar{V}_j^f(S_{it};\theta) \quad = \quad U_j^f(S_{it};\theta)+\beta E[V(S_{it+1},\varepsilon_{it+1})|S_{it},d_{it}]. \tag{21}$$

Let $b=1,\dots,4$ be an index for a nest. The likelihood of choosing labor supply choice $j\in\{h,r,n,l\}$ and fertility choice $f\in\{0,1\}$ is given by

$$\begin{aligned}& l^d(d_{j,it}=1,d_{it}^f=1|S_{it};\theta_k^d,\theta_k^y,\theta_k^{ym}) \\ = \quad & \frac{\sum_b(\mu_b\exp(\bar{V}_j^f))^{1/\lambda_b}\left(\sum_{j,f\in B_b}(\mu_b\exp(\bar{V}_j^f))^{1/\lambda_b}\right)^{\lambda_b-1}}{\sum_{b'=1}^4\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(\bar{V}_j^f))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}}\end{aligned} \tag{22}$$

where $\bar{V}_j^f(S_{it};\theta)$ is denoted as $\bar{V}_j^f$ for brevity. The parameter λ_b is a dissimilarity parameter and indicates the degree of independence among alternatives within the nest. It takes the value between zero and one, and a higher value of λ_b implies greater independence and less correlation. The parameter μ_b is an allocation parameter that reflects the extent to which an alternative is a member of nest b. To facilitate interpretation, it is assumed that $\mu_1=\mu_2$, $\mu_3=\mu_4$, and $1-\mu_1=\mu_3$.

B.2 The Algorithm

I first describe the estimation algorithm for the model in which individuals are homogeneous, which is based on Kasahara and Shimotsu (2011). I then explain how this estimation algorithm can be applied to the model in which individuals are heterogeneous, using the ESM algorithm proposed by Arcidiacono and Jones (2003). Following Arcidiacono, Bayer, Bugni, and James (2013), the value function is approximated based on sieves in both cases.

B.2.1 Homogeneous Individuals

When individuals are homogeneous, the log-likelihood is given by

$$\begin{aligned}& \ln L\left(\{d_i,y_{m,i},y_i\}_{i=1}^N|\{d_{i\tau(i)},S_{i\tau(i)}\}_{i=1}^N;\theta\right) \\ = \quad & \sum_{i=1}^N\sum_{t=\tau(i)+1}^{T_i}\ln l^d(d_{it}|S_{it};\theta^d,\theta^y,\theta^{ym})+\ln l^y(y_{it}|S_{it},d_{it};\theta^y)+\ln l^{ym}(y_{m,it}|S_{it-1},d_{it-1};\theta^{ym})\end{aligned} \tag{23}$$

Consistent estimates for the parameter vectors θ^y and θ^{ym} are given by

$$\hat{\theta}^y \equiv \arg\max_{\theta^y} \sum_{i=1}^{N} \sum_{t=\tau(i)+1}^{T_i} \ln l^y(y_{it}|S_{it}, d_{it}; \theta^y) \tag{24}$$

$$\hat{\theta}^{ym} \equiv \arg\max_{\theta^{ym}} \sum_{i=1}^{N} \sum_{t=\tau(i)+1}^{T_i} \ln l^{ym}(y_{m,it}|S_{it}, d_{it}; \theta^{ym}) \tag{25}$$

Note that the consistent estimates for the parameters $\hat{\theta}^y$ and $\hat{\theta}^{ym}$ can be obtained separately from the parameters in the utility function. Because estimation of these parameters $\hat{\theta}^y$ and $\hat{\theta}^{ym}$ is straightforward, I focus on the algorithm for estimating θ^d in the following.

The Bellman equation (10) can be rewritten in terms of the expectation of the value function

$$\begin{aligned} EV(S_{it}) &= E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta E[V(S_{it+1}, \varepsilon_{it+1})|S_{it}, d_{it}]\right] && (26) \\ &= E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta \int EV(S_{it+1}) dF(S_{it+1}|S_{it}, d_{it})\right], && (27) \end{aligned}$$

where expectation is taken over $\varepsilon_{j,it}^f$ and $F(\cdot|\cdot)$ is the cumulative distribution function for S_{it+1}. The Bellman operator is defined by the right hand side of the above equation so that

$$[\Gamma(\theta, EV)](S_{it}) \equiv E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta \int EV(S_{it+1}) dF(S_{it+1}|S_{it}, d_{it})\right]. \tag{28}$$

The Bellman equation (27) is compactly rewritten as $EV = \Gamma(\theta, EV)$. I also define the mapping $\Lambda(\theta, EV)$ as

$$[\Lambda(\theta, EV)](d_{j,it} = 1, d_{it}^f = 1|S_{it}) \equiv l^d(d_{j,it} = 1, d_{it}^f = 1|S_{it}; EV, \theta^d, \hat{\theta}^y, \hat{\theta}^{ym}). \tag{29}$$

The consistent estimate for the parameter vector θ^d is given by

$$\hat{\theta}^d = \arg\max_{\theta^d} \frac{1}{N} \sum_{i=1}^{N} \ln \Lambda(\theta^d, \hat{\theta}^y, \hat{\theta}^{ym}, EV) \text{ subject to } EV = \Gamma(\theta, EV). \tag{30}$$

Computation of the likelihood function by the nested fixed point algorithm by Rust (1987) requires solving the fixed points of $EV = \Gamma(\theta, EV)$ at each trial parameter value in maximizing the objective function with respect to θ^d. The q-NPL algorithm proposed by Kasahara and Shimotsu (2011) iterates the Bellman operator for only q times rather than finding fixed points.

Define a q-fold operator of Γ as $\Gamma^q(\theta, EV)$. Denote by $\widetilde{EV}(M)$ the estimates for the expected value function in the M th iteration. Starting from an initial estimate $\widetilde{EV}(0)$ for the expectation of the value function, the q-NPL algorithm iterates the following steps until $\widetilde{EV}$ and $\tilde{\theta}^d$ converge:

1. Given $\widetilde{EV}(M-1)$, update $\tilde{\theta}^d$ by

$$\tilde{\theta}^d(M) \quad = \quad \arg\max_{\theta^d} \frac{1}{N}\sum_{i=1}^{N} \ln \Lambda(\theta^d, \hat{\theta}^y, \hat{\theta}^{ym}, \Gamma^q(\theta, \widetilde{EV}(M-1))). \tag{31}$$

2. Update $\widetilde{EV}$ using the obtained estimate $\tilde{\theta}^d(M)$

$$\widetilde{EV}(M) \quad = \quad \Gamma^q(\tilde{\theta}(M), \widetilde{EV}(M-1)), \tag{32}$$

   where $\tilde{\theta}(M) = (\tilde{\theta}^d(M), \hat{\theta}^y, \hat{\theta}^{ym})$.

Kasahara and Shimotsu (2011) prove that this sequence converges when q is large enough and yields a consistent estimate for θ^d. I tried different values for q and find that $q = 6$ is a good choice in terms of the total computational time for the model and data in this paper.

To further accelerate computation of a model with a large state space, I approximate the Bellman operator by a higher order polynomial function, which is proposed by Arcidiacono, Bayer, Bugni, and James (2013). Let $W(S_{it})$ be a vector of polynomials of the state variables. Let ρ be a vector of parameters that approximates the value function. For any state variable S_{it}, the sieve approximation satisfies

$$W(S_{it})'\rho \quad \approx \quad EV(S_{it}). \tag{33}$$

Because the error terms in the utility function follow a generalized extreme value distribution, the closed form solution to $EV(S_{it})$ is given by

$$EV(S_{it}) \quad = \quad \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(\bar{V}_j^f))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right], \tag{34}$$

which implies that

$$W(S_{it})'\rho \quad \approx \quad EV(S_{it}) \tag{35}$$

$$= \quad \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(U_j^f(S_{it}) + \beta E[W(S_{it+1})'\rho|S_{it},d_{it}]))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right] \tag{36}$$

$$= \quad \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(U_j^f(S_{it}) + \beta E[W(S_{it+1})|S_{it},d_{it}]'\rho))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right]. \tag{37}$$

A key convenience of this approach based on a polynomial function is that the parameter ρ can be taken out of the expectation operator $E(\cdot)$ as it can be seen in the last equality. This can save the computational time, because the expectation of $E[W(S_{it+1})|S_{it},d_{it}]$ needs to be calculated only once as long as the parameters for transition probabilities remain the same.

B.2.2 Heterogeneous Individuals

In this subsection, I describe the algorithm for the case of heterogeneous individuals. The method described in the last subsection is combined with the EM algorithm developed by Arcidiacono and Jones (2003).

Expectation Step In the expectation step, I calculate the conditional probability of being in each unobserved type given the values of the parameters, choices, earnings, and observed state variables. Let $\tilde{\theta}(M-1)$ and $\tilde{\pi}(M-1)$ be the vectors of parameters obtained from the $(M-1)$-th iteration. The estimates for the expectation of the value function is denoted by $\widetilde{EV}(M-1)$. The likelihood of the observations on individual i given the parameters at the $(M-1)$-th iteration is

$$L_i^{(M-1)} = \mathscr{L}(d_i, y_{m,i}, y_i | z_{i\tau(i)}; \widetilde{EV}(M-1), \tilde{\theta}(M-1), \tilde{\pi}(M-1)). \tag{38}$$

Similarly, I denote by $L_{ik}^{(M-1)}$ the likelihood of the observations and being type k for individual i so that $L_i^{(M-1)} = \sum_k L_{ik}^{(M-1)}$. At iteration M, following from the Bayes rule, the probability of individual i being type k, $q_{ik}(M)$ is given by

$$q_{ik}(M) = \frac{L_{ik}^{(M-1)}}{L_i^{(M-1)}}. \tag{39}$$

Maximization Step The parameter vector is updated to $\tilde{\theta}(M)$ by choosing θ and π to maximize

$$\begin{aligned} & \sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M) \ln \mathscr{L}(d_i, y_{m,i}, y_i \mid d_{i\tau(i)}, S_{i\tau(i)}; \widetilde{EV}(M-1), \theta, \pi) \\ = & \sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M) \Bigg(\ln p_k(z_{i\tau(i)}; \pi) + \sum_{t=\tau(i)+1}^{T_i} \ln l^d(d_{it}|S_{it}; \widetilde{EV}(M-1), \theta_k) + \\ & \ln l^y(y_{it}|S_{it}, d_{it}; \theta_k^y) + \ln l^{ym}(y_{m,it}|S_{it-1}, d_{it-1}; \theta_k^{ym}) \Bigg). \end{aligned} \tag{40}$$

Because of the additive separability, I can maximize the objective function sequentially. Specifically, the updated parameter vectors are given by

$$\tilde{\pi}(M) = \arg\max_{\pi} \frac{1}{N}\sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M)\ln p_k(z_{i\tau(i)};\pi) \tag{41}$$

$$\tilde{\theta}^y(M) = \arg\max_{\theta^y} \frac{1}{N}\sum_{i=1}^{N}\sum_{k=1}^{K}\sum_{t=\tau(i)+1}^{T_i} q_{ik}(M)\ln l_k^y(y_{it}|S_{it},d_{it};\theta^y) \tag{42}$$

$$\tilde{\theta}^{ym}(M) = \arg\max_{\theta^{ym}} \frac{1}{N}\sum_{i=1}^{N}\sum_{k=1}^{K}\sum_{t=\tau(i)+1}^{T_i} q_{ik}(M)\ln l_k^{ym}(y_{m,it}|S_{it-1},d_{it-1};\theta^{ym}) \tag{43}$$

$$\tilde{\theta}^d(M) = \arg\max_{\theta^d} \frac{1}{N}\sum_{i=1}^{N} q_{ik}(M)\ln\Lambda(\theta^d,\tilde{\theta}^y(M),\tilde{\theta}^{ym}(M),\Gamma^q(\theta,\widetilde{EV}(M-1))). \tag{44}$$

In updating θ^d, the Bellman operator Γ is approximated by a higher order polynomial function as outlined above for the case of homogeneous individuals. Finally, the estimate of the expectation of the value function is updated by

$$\widetilde{EV}(M) = \Gamma^q(\tilde{\theta}(M),\widetilde{EV}(M-1)). \tag{45}$$

C Additional Tables

Table 20: Earnings Function for Husband

	Estimate	S.E.
Intercept (Type 1)	−0.425	0.350
Intercept (Type 2)	−0.102	0.349
Intercept (Type 3)	−0.394	0.347
Intercept (Type 4)	−0.360	0.348
Husband's Earnings	0.832	0.003
Age	0.065	0.019
Age-sq	−0.069	0.025
Sqrt. of No. Children	−0.008	0.023
Age of Youngest Child	−0.001	0.003
Reg.	−0.152	0.034
Non-Reg.	−0.103	0.031
PL	−0.098	0.099
Conception	0.055	0.039
Unempl. Rate	−0.009	0.017
Std. Dev. of Error Term	1.083	0.002

Note: The dependent variable is the level of earnings so that zero earnings can be included.

Table 21: Type Probability Function and Share

	Type 2		Type 3		Type 4	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept	−1.431	3.501	3.110	2.506	6.059	3.114
Some College	1.455	0.383	0.125	0.286	0.579	0.333
4-Yr College	3.014	0.999	0.329	0.984	1.621	0.993
Age	−0.071	0.131	−0.128	0.087	−0.206	0.115
Years in Home	0.627	0.472	−0.168	0.285	−0.261	0.325
Years in Reg.	0.278	0.350	0.169	0.285	−0.092	0.322
Years in Non-Reg.	−0.164	0.440	−0.271	0.289	−0.423	0.408
Age × Years in Home	−2.066	1.433	0.282	0.814	0.969	0.938
Age × Years in Reg.	−0.579	1.049	−0.169	0.853	0.407	0.981
Age × Years in Non-Reg.	0.592	1.300	1.011	0.818	1.064	1.232
Husband's Earnings	0.433	0.098	0.017	0.085	−0.013	0.101
Sqrt. of No. Children	0.319	0.325	0.621	0.264	0.255	0.304
Age of Youngest Child	−0.011	0.075	0.045	0.049	−0.007	0.064
Reg. in 1st Year	1.993	0.566	1.356	0.498	1.702	0.530
Non-Reg. in 1st Year	0.988	0.502	1.655	0.392	1.243	0.452
Conceived in 1st Year	−0.370	0.395	−0.591	0.350	−1.181	0.446

	Type 1	Type 2	Type 3	Type 4
Share	0.131	0.247	0.331	0.291

Table 22: Effects of Parental Leave Policies on Labor Market Outcomes

	Years Since Birth						
	-1	0	1	2	3	5	10
Work							
JP:0, RR:0%	1.00	0.19	0.33	0.34	0.39	0.46	0.58
JP:1, RR:0%	1.00	0.13	0.54	0.50	0.53	0.57	0.66
JP:3, RR:0%	1.00	0.14	0.54	0.48	0.55	0.59	0.67
JP:0, RR:50%	1.00	0.17	0.32	0.34	0.38	0.45	0.58
JP:1, RR:50%	1.00	0.11	0.55	0.50	0.53	0.58	0.67
JP:3, RR:50%	1.00	0.12	0.55	0.49	0.55	0.59	0.68
JP:0, RR:50% + Need to Take PL	1.00	0.19	0.35	0.36	0.40	0.47	0.59
JP:1, RR:50% + Need to Take PL	1.00	0.12	0.57	0.52	0.55	0.59	0.68
JP:3, RR:50% + Need to Take PL	1.00	0.12	0.56	0.50	0.56	0.60	0.69
On PL							
JP:0, RR:0%	0.00	0.12	0.02	0.01	0.01	0.00	0.00
JP:1, RR:0%	0.00	0.50	0.06	0.07	0.05	0.02	0.00
JP:3, RR:0%	0.00	0.54	0.12	0.15	0.09	0.05	0.01
JP:0, RR:50%	0.00	0.13	0.02	0.01	0.01	0.00	0.00
JP:1, RR:50%	0.00	0.52	0.06	0.08	0.06	0.03	0.00
JP:3, RR:50%	0.00	0.56	0.12	0.16	0.10	0.06	0.01
JP:0, RR:50% + Need to Take PL	0.00	0.15	0.02	0.02	0.01	0.00	0.00
JP:1, RR:50% + Need to Take PL	0.00	0.54	0.06	0.09	0.06	0.03	0.00
JP:3, RR:50% + Need to Take PL	0.00	0.57	0.13	0.17	0.10	0.06	0.01
Reg. Work							
JP:0, RR:0%	0.59	0.12	0.19	0.18	0.17	0.17	0.19
JP:1, RR:0%	0.59	0.07	0.34	0.31	0.30	0.29	0.29
JP:3, RR:0%	0.59	0.08	0.33	0.29	0.31	0.30	0.30
JP:0, RR:50%	0.59	0.10	0.18	0.17	0.16	0.16	0.19
JP:1, RR:50%	0.59	0.06	0.36	0.31	0.31	0.30	0.30
JP:3, RR:50%	0.59	0.06	0.34	0.29	0.31	0.31	0.32
JP:0, RR:50% + Need to Take PL	0.59	0.12	0.21	0.19	0.19	0.18	0.20
JP:1, RR:50% + Need to Take PL	0.59	0.07	0.37	0.33	0.32	0.31	0.32
JP:3, RR:50% + Need to Take PL	0.59	0.07	0.35	0.30	0.32	0.32	0.33
Non-Reg. Work							
JP:0, RR:0%	0.41	0.07	0.14	0.17	0.22	0.29	0.39
JP:1, RR:0%	0.41	0.05	0.20	0.19	0.23	0.28	0.36
JP:3, RR:0%	0.41	0.06	0.21	0.20	0.24	0.29	0.36
JP:0, RR:50%	0.41	0.07	0.14	0.17	0.22	0.29	0.39
JP:1, RR:50%	0.41	0.05	0.20	0.19	0.23	0.28	0.36
JP:3, RR:50%	0.41	0.06	0.21	0.20	0.24	0.28	0.36
JP:0, RR:50% + Need to Take PL	0.41	0.07	0.14	0.17	0.22	0.29	0.39
JP:1, RR:50% + Need to Take PL	0.41	0.05	0.20	0.19	0.22	0.28	0.36
JP:3, RR:50% + Need to Take PL	0.41	0.06	0.21	0.20	0.24	0.28	0.36
Earnings (mil. JPY)							
JP:0, RR:0%	2.62	0.54	0.71	0.80	0.81	0.87	1.11
JP:1, RR:0%	2.62	0.30	1.05	1.32	1.30	1.38	1.59
JP:3, RR:0%	2.62	0.32	1.01	1.19	1.26	1.38	1.63
JP:0, RR:50%	2.62	0.46	0.66	0.77	0.78	0.84	1.09
JP:1, RR:50%	2.62	0.26	1.06	1.34	1.31	1.41	1.64
JP:3, RR:50%	2.62	0.27	1.02	1.21	1.28	1.42	1.70
JP:0, RR:50% + Need to Take PL	2.62	0.51	0.76	0.87	0.88	0.94	1.16
JP:1, RR:50% + Need to Take PL	2.62	0.28	1.11	1.40	1.37	1.48	1.70
JP:3, RR:50% + Need to Take PL	2.62	0.29	1.05	1.25	1.32	1.45	1.74

Table 23: Effects of Parental Leave Policies on Fertility

	Years Since Birth						
	-1	0	1	2	3	5	10
Pregnancy							
JP:0, RR:0%	1.00	0.04	0.13	0.10	0.06	0.03	0.00
JP:1, RR:0%	1.00	0.04	0.15	0.12	0.07	0.04	0.00
JP:3, RR:0%	1.00	0.04	0.16	0.13	0.08	0.04	0.00
JP:0, RR:50%	1.00	0.04	0.13	0.10	0.06	0.03	0.00
JP:1, RR:50%	1.00	0.04	0.16	0.12	0.07	0.04	0.00
JP:3, RR:50%	1.00	0.04	0.16	0.14	0.08	0.05	0.00
JP:0, RR:50% + Need to Take PL	1.00	0.04	0.13	0.10	0.06	0.03	0.00
JP:1, RR:50% + Need to Take PL	1.00	0.04	0.16	0.12	0.07	0.04	0.00
JP:3, RR:50% + Need to Take PL	1.00	0.04	0.16	0.14	0.08	0.05	0.00
Number of Children							
JP:0, RR:0%	0.59	1.64	1.69	1.82	1.92	2.02	2.10
JP:1, RR:0%	0.59	1.64	1.68	1.83	1.95	2.07	2.15
JP:3, RR:0%	0.59	1.64	1.68	1.84	1.97	2.10	2.20
JP:0, RR:50%	0.59	1.64	1.69	1.82	1.92	2.03	2.10
JP:1, RR:50%	0.59	1.64	1.68	1.84	1.96	2.09	2.18
JP:3, RR:50%	0.59	1.64	1.68	1.84	1.98	2.12	2.23
JP:0, RR:50% + Need to Take PL	0.59	1.64	1.69	1.81	1.91	2.02	2.09
JP:1, RR:50% + Need to Take PL	0.59	1.64	1.68	1.84	1.96	2.09	2.18
JP:3, RR:50% + Need to Take PL	0.59	1.64	1.68	1.84	1.98	2.12	2.23

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